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AD
RDTE PROJECT NO.
USAAVSCOM PROJECT NO. 69-01
USAASTA PROJECT NO. 69-01

AIRWORTHINESS AND FLIGHT CHARACTERISTICS AH-IG HELICOPTER WITH STABILIZED NIGHT SIGHT (SNS)

PHASE I

FINAL REPORT

GARY L. BENDER
PROJECT ENGINEER

MARVIN W. BUSS
PROJECT OFFICER/PILOT

DECEMBER 1969

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US ARMY AVIATION SYSTEMS TEST ACTIVITY
EDWARDS AIR FORCE BASE, CALIFORNIA 93523

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PHASE I

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ABSTRACT

The Phase I airworthiness and flight characteristics tests of the AH-1G helicopter with the mock-up stabilized night sight (SNS) installed indicated a feasibility for further development utilizing the actual SNS equipment. No significant changes in the handling qualities due to the SNS modification were noted during the tests. The static, proof load test results indicate that the structure is adequate tc withstand the required loads. The flight test data from the three nonrotating control boost tubes show higher loads for the AH-1G in both the SNS and standard nose configurations than the Bell Helicopter Company test data. The control boost tube loads reached the maximum permitted at conditions short of the published envelope. Testing was terminated early to obtain instrumented components (rotor blade, drag brace and pitch link) so the flight envelope and/or fatigue life of these components could be more accurately determined. These tests are scheduled to be completed during Phase II with the actual SNS installed. The vertical six-per-revolution vibrations at the copilot's seat exceed military specification requirements in the SNS configuration.

TABLE OF CONTENTS

INTRODUCTION

BACKGROUND

1. The stabilized night sight (SNS) system is being developed to improve the night tactical operations capability of various weapons systems currently in the Army inventory. The SNS is being developed by the Itek Corporation for the US Army Mobility Equipment Research and Development Center under contract number DAAK-02-78-C-0491. The design and initial testing of the SNS is being accomplished by Itek Optical Systems Division (OSD), Burlington, Massachusetts. The fabrication of attachment structure and the installation of the mock-up SNS and functioning system are being accomplished by Itek Lincoln Aerospace Division (LAD), Lincoln, Nebraska. Since installation of the SNS on the AH-1G required significant modification of the basic aircraft structure and external shape, the US Army Aviation Systems Command (USAAVSCOM) was designated to evaluate the airworthiness and flight characteristics (A&FC) tests on the AH-1G, S/N 66-15293, in two phases. The first phase determined the feasibility of installing the system on the AH-1G by conducting tests with a mock-up SNS installed. The second phase will evaluate the aircraft with the actual SNS installed and also provide the data to issue a safety-of-flight release for further SNS performance and operational capability tests. The static test methods, results and conclusions are described in reference 1, appendix I.

TEST OBJECTIVES

2. The objectives of the Phase I test program were as follows:

a. Determine the structural adequacy of the SNS installation on the AH-1G by static, proof load testing.

b. Determine A&FC of the AH-1G with a mock-up SNS installed.

c. Obtain quantitative and qualitative data to develop a flight envelope and safety-of-flight release for further prototype functional and operational testing with a functional SNS installed.

DESCRIPTION

3. The tests were conducted on a standard AH-1G helicopter, S/N 66-15293, with the XM28 weapon system installed prior to structural

modification forward of fuselage station (FS) 61 in order to install the mock-up SNS. The aircraft was instrumented to record stability and control parameters; limited performance parameters; structural load data in the mock-up SNS and attachment areas; span, chord and torsion loads on the horizontal stabilizer and nonrotating control boost tube axial loads. The data were recorded for each test condition on a 50-channel oscillograph mounted in the ammunition compartment.

4. The SNS is a multipurpose viewer having a modular design capability as follows:

a. Provides the user a sight for accurate aiming of aircraft mounted weapons at night.

b. Provides high resolution surveillance and target acquisition from moving vehicles.

c. Provides remote viewing for operational control by using a flexible fiber optic rope.

5. The mock-up SNS was installed in the nose of the AH-1G forward of FS 46. The mock-up was designed to have the same external shape and the same mass distribution as the production SNS. The weight of the mock-up was 285 pounds. One hundred pounds of ballast were installed in the tail above the stinger attachment to maintain the center of gravity (cg) within limits.

SCOPE OF TEST

6. Phase I of the A&FC tests was limited in scope to obtaining structural, control load and stability and control data for those test conditions established as the envelope was expanded. Testing was conducted at Edwards Air Force Base, California, and the minimum usable density altitude (H_D) was 5000 feet.

7. Eighteen flights were conducted totaling 11.5 hours.

8. The test conditions are shown in table 1.

Table 1. Test Conditions.

Aircraft Configuration[1]	Gross Weight (lb)	Average Density Altitude (ft)	Mid Center of Gravity (in.)	Rotor Speed (rpm)	Mock-up SNS
Clean	7560	5000	195.8	324	Installed
Clean	7560	5000	195.8	324	Removed
Clean	8610	5000	197.1	324	Installed
Hog	8415	5000	194.5	324	Installed
Hog	9270	5000	194.5	324	Removed
Hog	9270	5000	194.5	324	Installed

[1]The clean configuration had no wing stores; the hog configuration had two XM159 pods on each wing.

METHOD OF TEST

9. The method used during envelope expansion was to increase the airspeed, normal acceleration and maneuver rates in increments. The data from each flight were processed and analyzed before determining the test conditions for the next flight. Standard configuration loads and control characteristics data used for comparison were obtained from previous USAASTA and Bell Helicopter Company (BHC) flight test reports (ref 2, app I). Limited base-line data were obtained with the test aircraft in a standard nose configuration. Static stability characteristics were determined from data recorded during stabilized flight in each of the desired conditions within the developed flight envelope. Dynamic stability and controllability were qualitatively evaluated and compared with the standard AH-1G characteristics throughout the conduct of the test.

CHRONOLOGY

10. The chronology of the Phase I test program is as follows:

Test helicopter received	5 March 1969
Test directive received	18 March 1969
Test plan submitted	April 1969
Static, proof load tests completed	10 May 1969
Flight testing initiated	29 May 1969
Flight testing completed	26 June 1969
Aircraft delivered to contractor for installation of SNS	30 June 1969
Draft report submitted	October 1969

RESULTS AND DISCUSSION

STATIC, PROOF LOAD TESTS

11. The results and discussion of the static, proof load tests conducted by USAASTA and National Aeronautics and Space Administration (NASA) personnel at the NASA Flight Research Center's high-temperature loads calibration facility are contained in the Flight Research Center's working paper (ref 1, app I). The concluding remarks of this paper state the following:

a. All the static load tests on the AH-1G helicopter requested by USAASTA, Edwards Air Force Base, California, were performed without damage of any kind to the vehicle.

b. The structural displacements were small, and no evidence of incipient failure was observed.

c. All measured strains and stresses appeared to be well below the yield strengths of the materials upon which the strain gages were mounted.

AIRWORTHINESS AND STRUCTURAL LOADS TESTS

12. The data for the structural loads in the mock-up SNS and attachment structure for all conditions tested indicated lower stress levels than those experienced during the static, proof load tests. Visual inspection of the critical areas at the completion of the testing revealed no evidence of cracking or fatigue damage.

13. Additional strain gage instrumentation was installed on the three nonrotating control boost tubes for the flight tests. These parameters were selected as indicators of any increase in loads in the critical areas of the rotating components due to the SNS modification. The maximum allowable load value for the three control boost tubes was established by AMSAV-R-FS and was forwarded to USAASTA in letters dated 27 March 1969 and 1 July 1969. The limit value for the flight testing was 2000 pounds (oscillatory) in any one of the control boost tubes. The oscillatory control boost tube data (one-half peak to peak) are presented in figures 1 through 15, appendix II.

14. The data show load values approaching the defined limit of ±2000 pounds at conditions well short of the published AH-1G operating envelope. Testing in the SNS configuration was limited to

those conditions where the maximum allowable load was not exceeded since the critical rotating components were not instrumented. To obtain reference data, flights were then flown in the standard nose configuration. The control boost tube load values were less in this configuration but they still exceeded the defined limit of ±2000 pounds for some conditions. The maximum (±2600 pounds) longitudinal boost tube load was recorded in the standard nose configuration at: 141.5 knots calibrated airspeed (KCAS), a 2.35g normal acceleration, a 7560-pound gross weight (grwt) and a density altitude of 5000 feet. The following was shown by the data:

a. In the standard nose configuration, oscillatory load data obtained in level flight at a 5000-foot H_D agree (within 100 pounds) with the interpolated BHC data for both the longitudinal and collective boost tubes. The lateral boost tube data show higher loads (maximum deviation was 200 pounds) for the test aircraft.

b. With the mock-up SNS installed, oscillatory load data obtained in level flight at a 5000-foot H_D and a 9270-pound grwt show maximum load increases of 100 pounds in the longitudinal boost tube, 300 pounds in the lateral boost tube and 50 pounds in the collective boost tube. At a 7560-pound grwt and a 5000-foot H_D, the boost tube loads for level flight show very little difference due to the SNS installation.

c. During symmetrical pullouts at 116.5 KCAS with the standard nose installed, the longitudinal and collective boost tube loads recorded are approximately 100 pounds greater than the BHC data at 2.0g's. The lateral boost tube loads are approximately 200 pounds greater than the BHC data at 2.0g's. During symmetrical pullouts at 141.5 KCAS, collective boost tube loads recorded show reasonable agreement with the BHC data. The longitudinal and lateral boost tube loads, however, are approximately 400 pounds greater at 2.0g's than the BHC data. Under these conditions, the longitudinal boost tube loads reach 2000 pounds at an approximate 2g normal acceleration.

d. For dive airspeeds greater than maximum airspeed for level flight (V_H), reduced power settings for the same airspeed results in a reduction of the boost tube loads. For constant power settings less than maximum, the rate of increase in the boost tube loads with increasing airspeed is the same as that at the maximum power setting.

e. At airspeeds above 140 KCAS using maximum power at a 7560-pound grwt and a 5000-foot H_D, the longitudinal boost tube loads increase with airspeed similarly to a linear extrapolation of BHC level-flight data and reach 2000 pounds at 170 KCAS. The lateral

boost tube loads increase moderately with airspeed; whereas, an extrapolation of BHC data indicates a slight decrease. The collective boost tube loads increase rapidly with airspeed from approximately 450 pounds at 140 KCAS to 2000 pounds at 180 KCAS. BHC data at a 6500-pound grwt show a similar trend (only BHC data presented above 140 KCAS at 5000 feet).

f. With the mock-up SNS installed, the loads during symmetrical pullouts were greater for all three control boost tubes. At 116.5 KCAS and a 2g normal acceleration, the recorded loads were approximately 450 pounds greater in the longitudinal boost tube, 550 pounds greater in the lateral boost tube and 400 pounds greater in the collective boost tube than the data for the test aircraft with the standard nose installed. At 141.5 KCAS and a 1.4g normal acceleration, the increase was approximately 150 pounds in the lateral boost tube and 50 pounds in the collective boost tube. The longitudinal boost tube loads data were inconclusive at 141.5 KCAS.

g. The technique used to obtain loads data during this test program was to use the maximum collective setting (power required for V_H) for all dive air speeds above the design V_H. Data were also obtained at 150 KCAS to determine the effect of reduced collective settings and increased dive angles on the boost tube loads at an airspeed greater than V_H. The results presented in figures 1, 2 and 3 show a significant reduction in the loads as the collective was reduced and the dive angle was increased.

h. The technique used during the symmetrical pullout tests was to maintain the level-flight collective setting throughout the maneuver. The desired normal acceleration (g) was established by making a smooth cyclic input such that the target g and airspeed were obtained as the aircraft passed through the level flight attitude. The target conditions of g and airspeed can also be obtained by establishing constant airspeed and cyclic induced pitch rates and then applying various collective inputs to achieve the desired g values. The qualitative opinion is that the two techniques will produce significantly different loads in the rotor system.

15. The higher boost tube loads data (higher than BHC) indicate a potential problem for the SNS configured AH-1G either in fatigue life of the critical rotating components or in operating envelope. The higher-than-expected control tube loads in both nose configurations should be further studied. Further flight tests with all critical rotating components instrumented should be conducted during Phase II tests to determine the cause of the increased loads and what effect the new load values have on the fatigue life of the components.

PERFORMANCE

16. Performance data were not obtained during the Phase I tests due to the restricted envelope available and the early curtailment of the flight tests.

STABILITY AND CONTROL

17. The results of the static longitudinal stability and static lateral-directional stability tests are shown in figures 16 through 20, appendix II. No significant differences from standard AH-1G characteristics were noted. Qualitative evaluations of the controllability and dynamic stability characteristics indicate that no significant differences existed in the handling qualities of the AH-1G with the mock-up SNS installed.

VIBRATION

18. The results of the vibration tests are shown in figures 21 through 24, appendix II. The vibration data were recorded at the copilot's position for vertical and lateral accelerations. The data indicate no significant differences between standard nose and the mock-up SNS configurations for one- and two-per-revolution frequencies. The vertical six-per-revolution vibration is slightly greater (0.1g) for the SNS configuration at light gross weight and considerably greater at the heavy gross weight in the hog configuration. The vertical six-per-revolution vibrations were 32.4 Hertz with the mock-up SNS installed and exceeded the vibration requirements of paragraph 3.7.1(b), MIL-H-8501A (0.15g below cruise airspeed and 0.2g above cruise airspeed). The lateral four-per-revolution vibrations were 21.1 Hertz and exceeded the specification in the standard configuration at light gross weight above cruise airspeed (V_{cruise}).

CONCLUSIONS

19. The tests indicate no significant change in the handling qualities of the AH-1G helicopter due to the installation of the mock-up SNS (para 17).

20. The cause of the higher loads in the nonrotating control boost tubes and its effect on the fatigue life of critical components must be further analyzed when data from the Phase II tests are available. Since the data indicate higher loads for both the standard and SNS configurations, the fatigue life and flight envelope may be affected for all AH-1G aircraft (para 15).

21. The vibration data show that the vertical six-per-revolution (32.4 Hertz) and lateral four-per-revolution (21.1 Hertz) vibration exceed the limits of MIL-H-8501A (para 18).

22. Further testing with a production SNS installed and in the standard configuration is required to define the flight envelope, performance and fatigue life of the main rotor (paras 15 and 16).

RECOMMENDATIONS

23. Further testing with a production SNS installed on the AH-1G should be accomplished to provide the required performance and load data so a flight release can be defined (para 22).

24. Future flight loads surveys should be conducted to the limits of any proposed operating envelope, and the techniques for achieving the required test conditions should be clearly defined (para 20).

25. The six-per-revolution vertical vibration with the SNS installed should be reduced to the levels specified in MIL-H-8501A (para 21).

APPENDIX I. REFERENCES

1. Working Paper, National Aeronautics and Space Administration (NASA) Flight Research Center, *Static Load Tests of a Simulation Package on an AH-1G Helicopter,* 11 July 1969.

2. Report, Bell Helicopter Company, 209-947-041, *Specification for Flight Load Survey on the Model AH-1G Helicopter,* 18 July 1966.

3. Letter, with inclosure, USAAVSCOM, subject: Test Directive, USAAVSCOM, No. 69-01, "Airworthiness Qualification of the Stabilized Night Sight on the AH-1G," 18 March 1969.

4. Test Plan, USAASTA, Project No. 69-01, *Airworthiness and Flight Characteristics of the AH-1G with Stabilized Night Sight (SNS),* June 1969.

5. Military Specification, MIL-H-8501A, *Helicopter Flying and Ground Handling Qualities; General Requirements For,* with Amendment 1, 3 April 1962.

6. Letter, USAASTA, subject: Interim Progress Report, Airworthiness and Flight Characteristics Tests of the Stabilized Night Sight on the AH-1G Helicopter, 16 June 1969.

7. Letter, USAASTA, subject: Airworthiness and Flight Characteristics Tests of the Stabilized Night Sight on the AH-1G Helicopter, 17 July 1969.

8. Message, USAAVSCOM, AMSAV-P-FS, subject: Safety-of-Flight Release for Flight Test of the Itek Stabilized Night Sight, 24 May 1969, (Unclassified).

APPENDIX II. TEST DATA

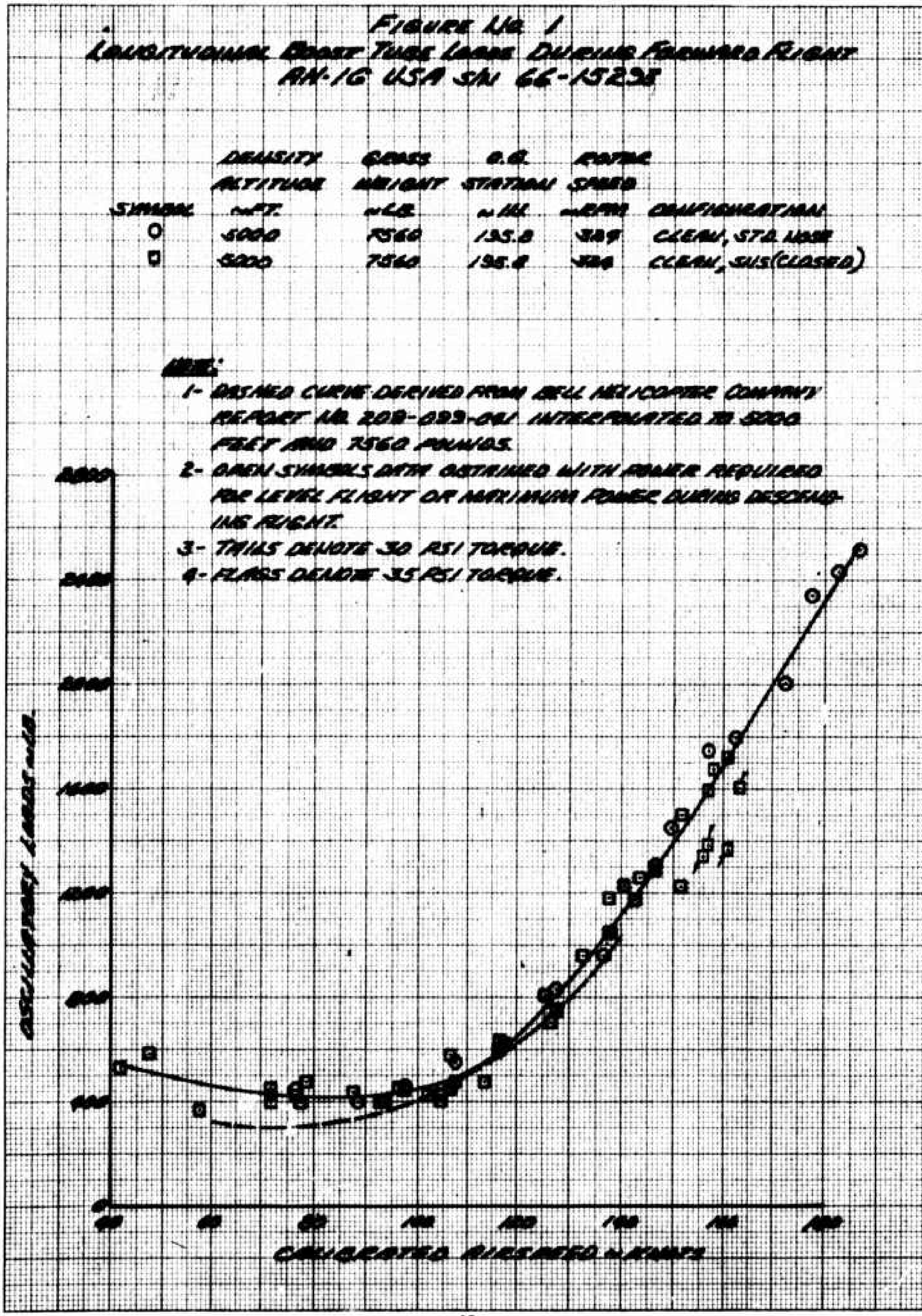


FIGURE NO. 1
LONGITUDINAL BOOST TUBE LOADS DURING FORWARD FLIGHT
AH-1G USA S/N 66-15238
SYMBOL | DENSITY ALTITUDE ~FT. | GROSS WEIGHT ~LB. | C.G. STATION ~IN. | ROTOR SPEED ~RPM | CONFIGURATION
○ | 5000 | 7560 | 195.8 | 324 | CLEAN, STD. NOSE
□ | 5000 | 7560 | 195.8 | 324 | CLEAN, SUS (CLOSED)
NOTE:
1- DASHED CURVE DERIVED FROM BELL HELICOPTER COMPANY REPORT NO. 209-099-041 INTERPOLATED TO 5000 FEET AND 7560 POUNDS.
2- OPEN SYMBOLS DATA OBTAINED WITH POWER REQUIRED FOR LEVEL FLIGHT OR MAXIMUM POWER DURING DESCENDING FLIGHT.
3- TAILS DENOTE 30 PSI TORQUE.
4- FLAGS DENOTE 35 PSI TORQUE.
OSCILLATORY LOADS ~LB.
CALIBRATED AIRSPEED ~KNOTS

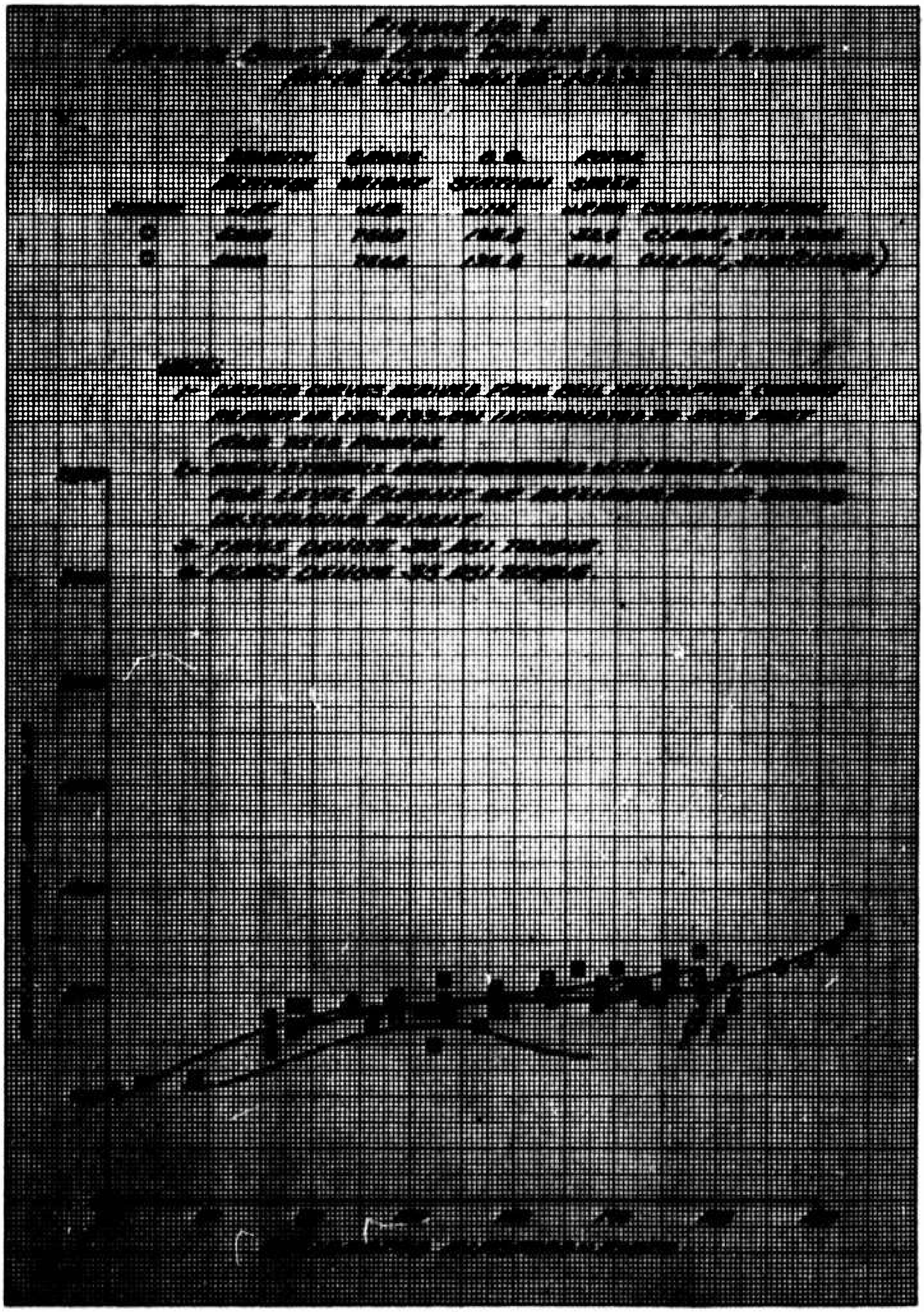


FIGURE NO. 3
COLLECTIVE BOOST TUBE LOADS DURING FORWARD FLIGHT
AH-1G USA S/N 66-15293

SYMBOL	DENSITY ALTITUDE ~FT.	GROSS WEIGHT ~LB.	C.G. STATION ~IN.	ROTOR SPEED ~RPM	CONFIGURATION
○	5000	7560	195.8	324	CLEAN, STD. NOSE
□	5000	7560	195.8	324	CLEAN, SUS (CLOSED)

NOTE:

1- DASHED CURVE DERIVED FROM BELL HELICOPTER COMPANY REPORT NO. 209-099-081 INTERPOLATED TO 5000 FEET AND 7560 POUNDS.
2- OPEN SYMBOLS DATA OBTAINED WITH POWER REQUIRED FOR LEVEL FLIGHT OR MAXIMUM POWER DURING DESCENDING FLIGHT.
3- TAILS DENOTE 30 PSI TORQUE.
4- FLAGS DENOTE 35 PSI TORQUE.

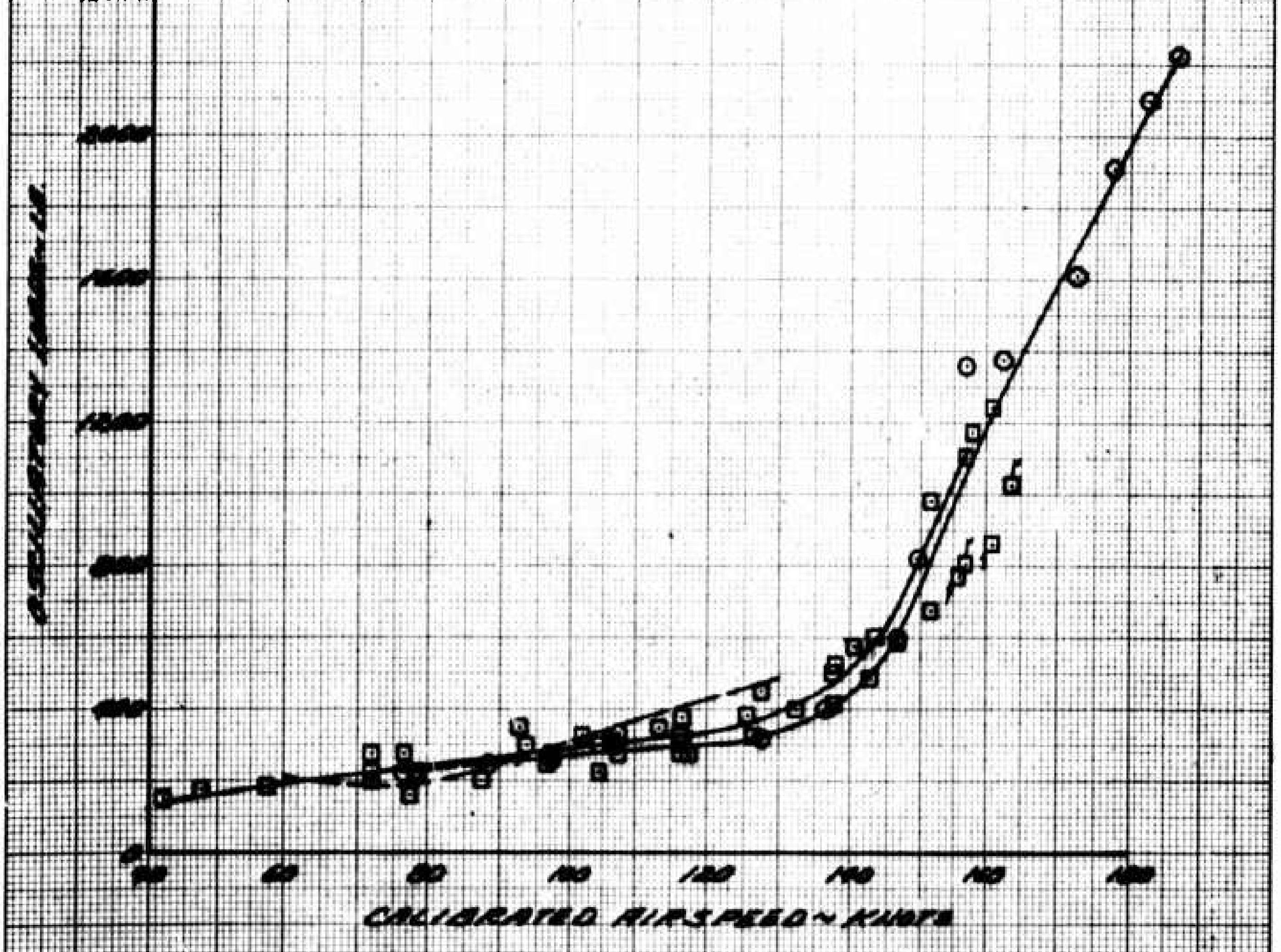


FIGURE No. 4
LONGITUDINAL BOOST TUBE LOADS DURING FORWARD FLIGHT
AH-1G USA S/N 66-15233

SYMBOL	DENSITY ALTITUDE ~ FT.	GROSS WEIGHT ~ LB.	C.G. STATION ~ IN.	ROTOR SPEED ~ RPM	CONFIGURATION
◆	5000	8615	194.5	[illegible]	[illegible], SAS (CLOSED)
△	5000	8610	195.1	324	CLEAN, SAS (CLOSED)

NOTE:

1- DASHED CURVE DERIVED FROM BELL HELICOPTER COMPANY REPORT NO. 209-099-081 INTERPOLATED TO 5000 FEET AND GROSS WEIGHT DENOTED.
2- DATA OBTAINED WITH POWER REQUIRED FOR LEVEL FLIGHT.

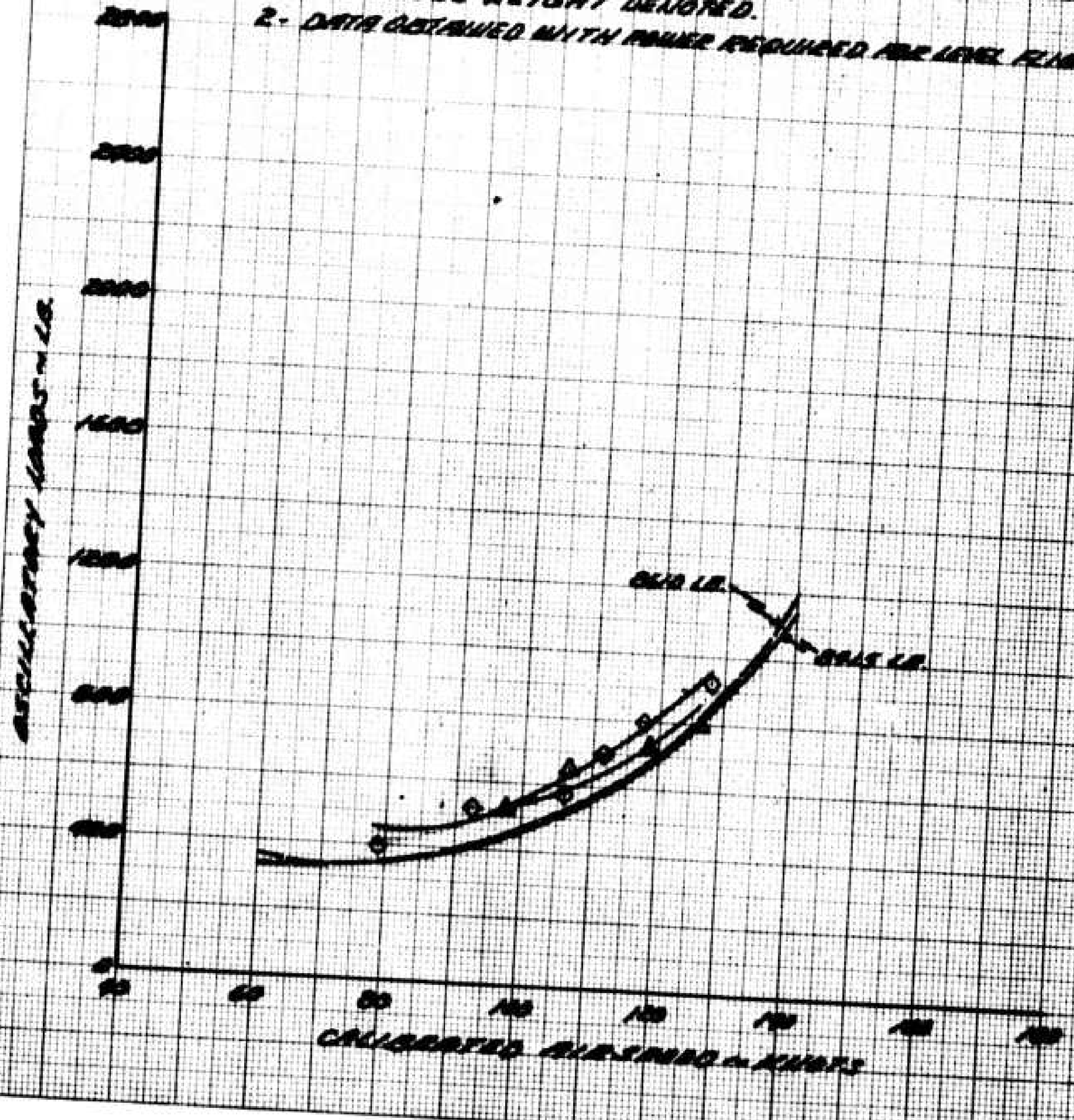
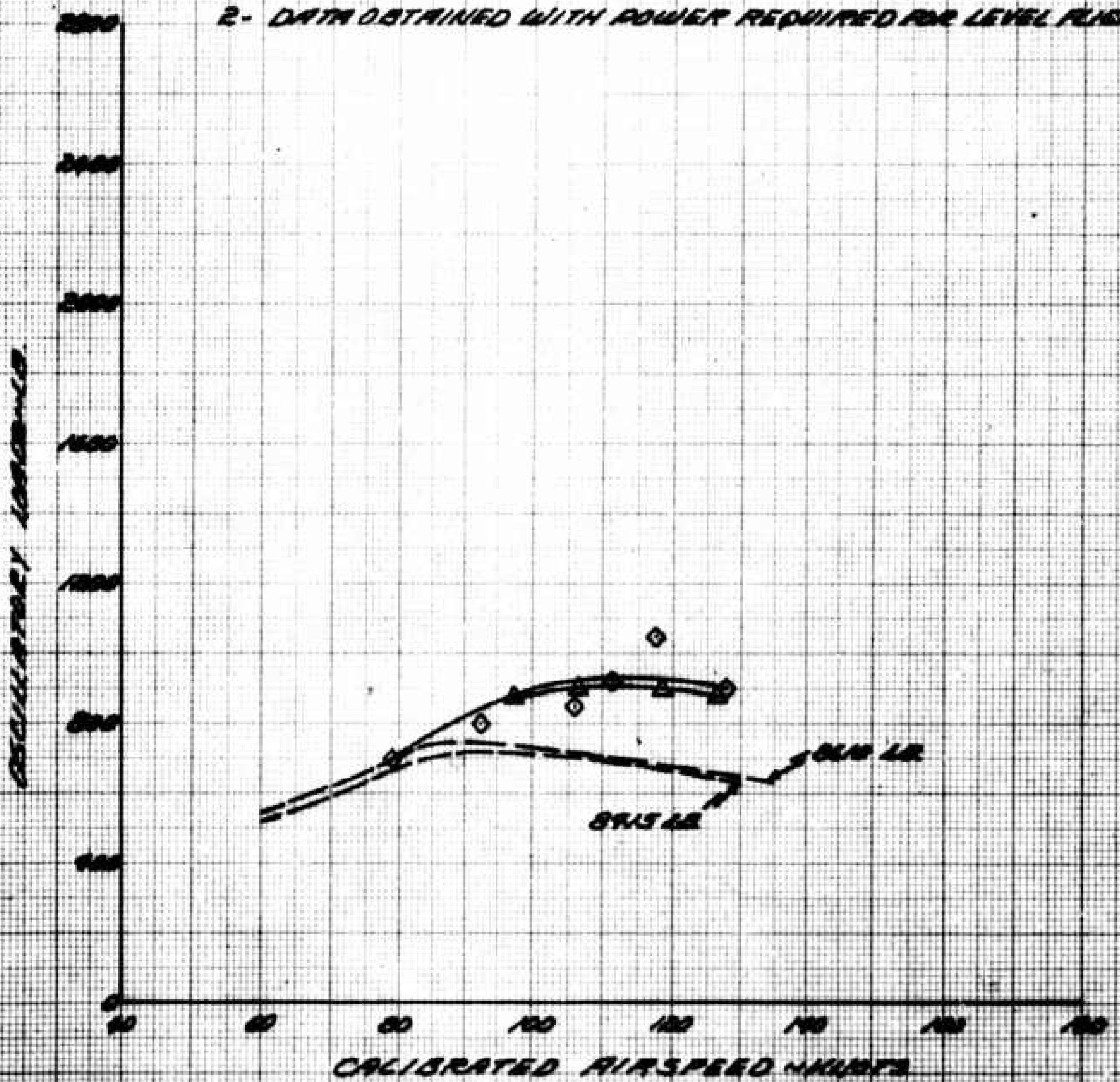


FIGURE NO. 5
LATERAL BOOST TUBE LOADS DURING FORWARD FLIGHT
AH-1G USA S/N 66-15293

SYMBOL	DENSITY ALTITUDE ~FT.	GROSS WEIGHT ~LB.	C.G. STATION ~IN.	ROTOR SPEED ~RPM	CONFIGURATION
◇	5000	8915	199.5	324	MOD, SAS (CLOSED)
△	5000	8610	197.1	324	CLEAN, SAS (CLOSED)

NOTE:
1- DASHED CURVE DERIVED FROM BELL HELICOPTER COMPANY REPORT NO. 209-099-041 INTERPOLATED TO 5000 FEET AND GROSS WEIGHT DENOTED.
2- DATA OBTAINED WITH POWER REQUIRED FOR LEVEL FLIGHT.



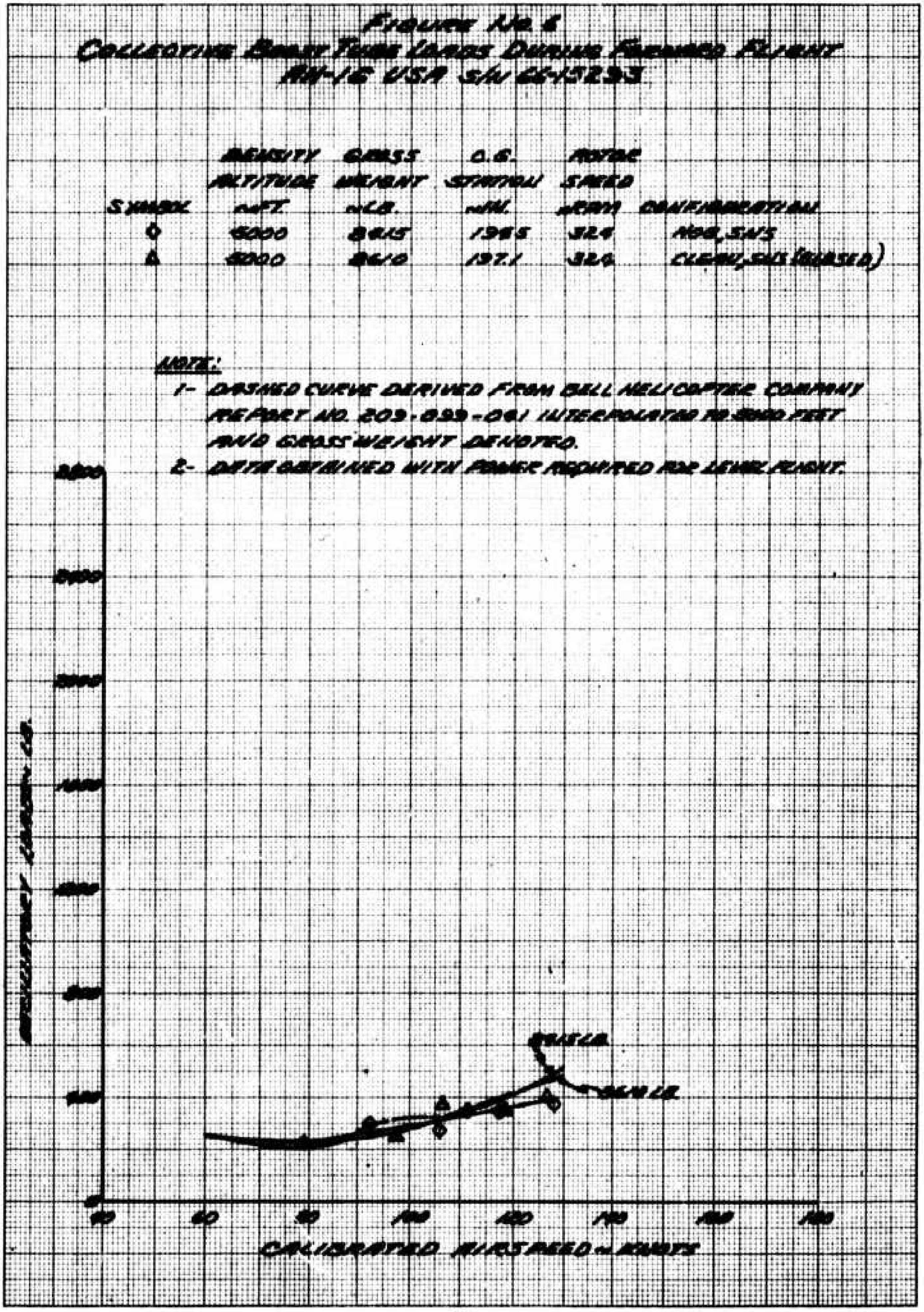
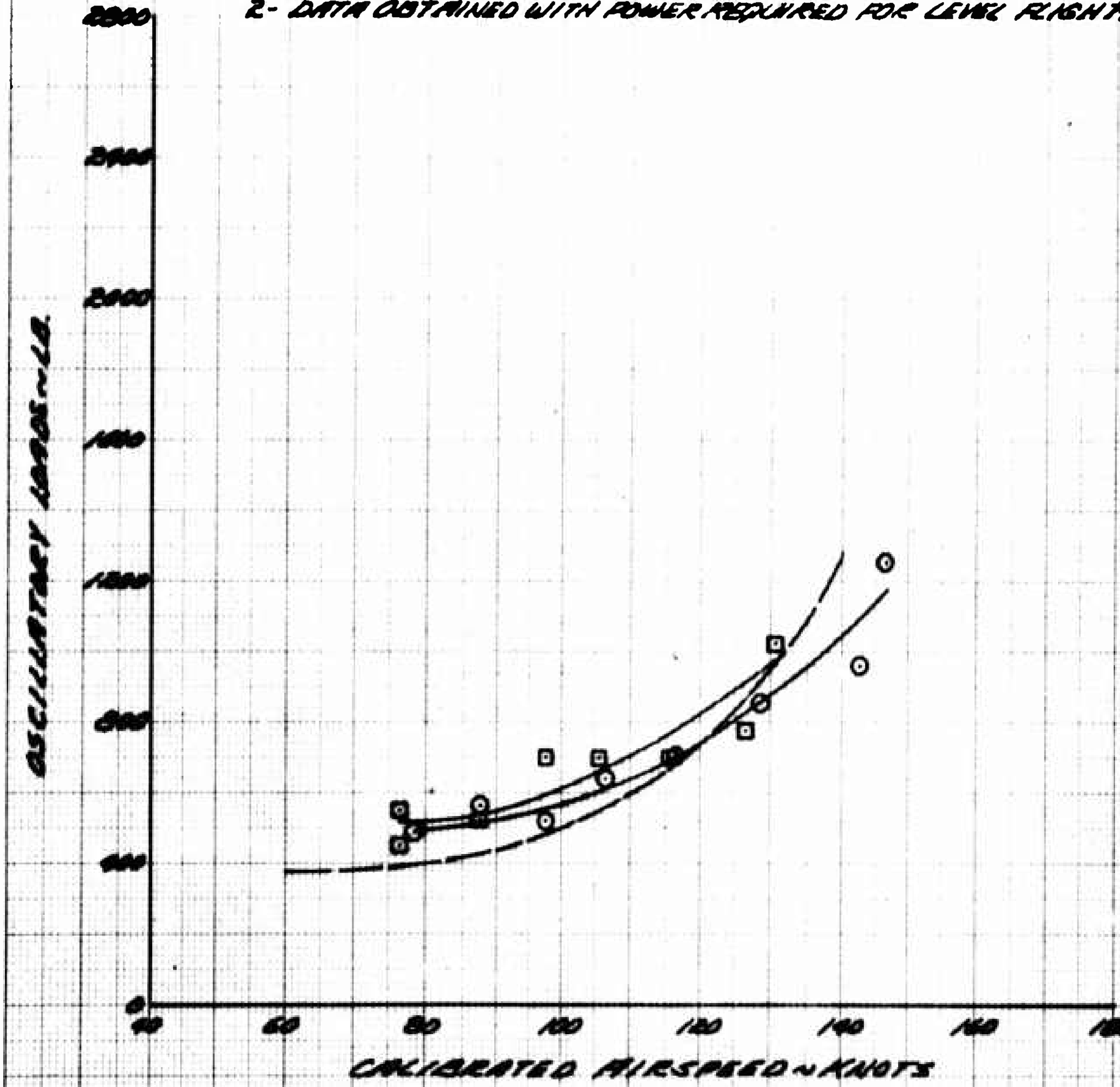


FIGURE NO. 6
COLLECTIVE BOOST TUBE LOADS DURING FORWARD FLIGHT
DENSITY ALTITUDE ~FT.
GROSS WEIGHT ~LB.
C.G. STATION ~IN.
ROTOR SPEED ~RPM
SYMBOL
CONFIGURATION
5000 8615 136.5 324
5000 8610 137.1 324
NOTE:
1- DASHED CURVE DERIVED FROM BELL HELICOPTER COMPANY REPORT NO. 203-099-061 INTERPOLATED TO 5000 FEET AND GROSS WEIGHT DENOTED.
2- DATA OBTAINED WITH POWER REQUIRED FOR LEVEL FLIGHT.
8615 LB.
8610 LB.
CALIBRATED AIRSPEED ~ KNOTS

FIGURE NO. 7
LONGITUDINAL BOOST TUBE LOADS DURING FORWARD FLIGHT
AH-1G USA S/N 66-15293

SYMBOL	DENSITY ALTITUDE ~FT.	GROSS WEIGHT ~LB.	C.G. STATION ~IN.	ROTOR SPEED ~RPM	CONFIGURATION
O	5000	9270	194.5	324	HOG, STD. NOSE
□	5000	9270	194.5	324	HOG, SNS(CLOSED)

NOTE:
1- DASHED CURVE DERIVED FROM BELL HELICOPTER COMPANY REPORT NO. 209-099-091 INTERPOLATED TO 5000 FEET AND 9270 POUNDS.
2- DATA OBTAINED WITH POWER REQUIRED FOR LEVEL FLIGHT.



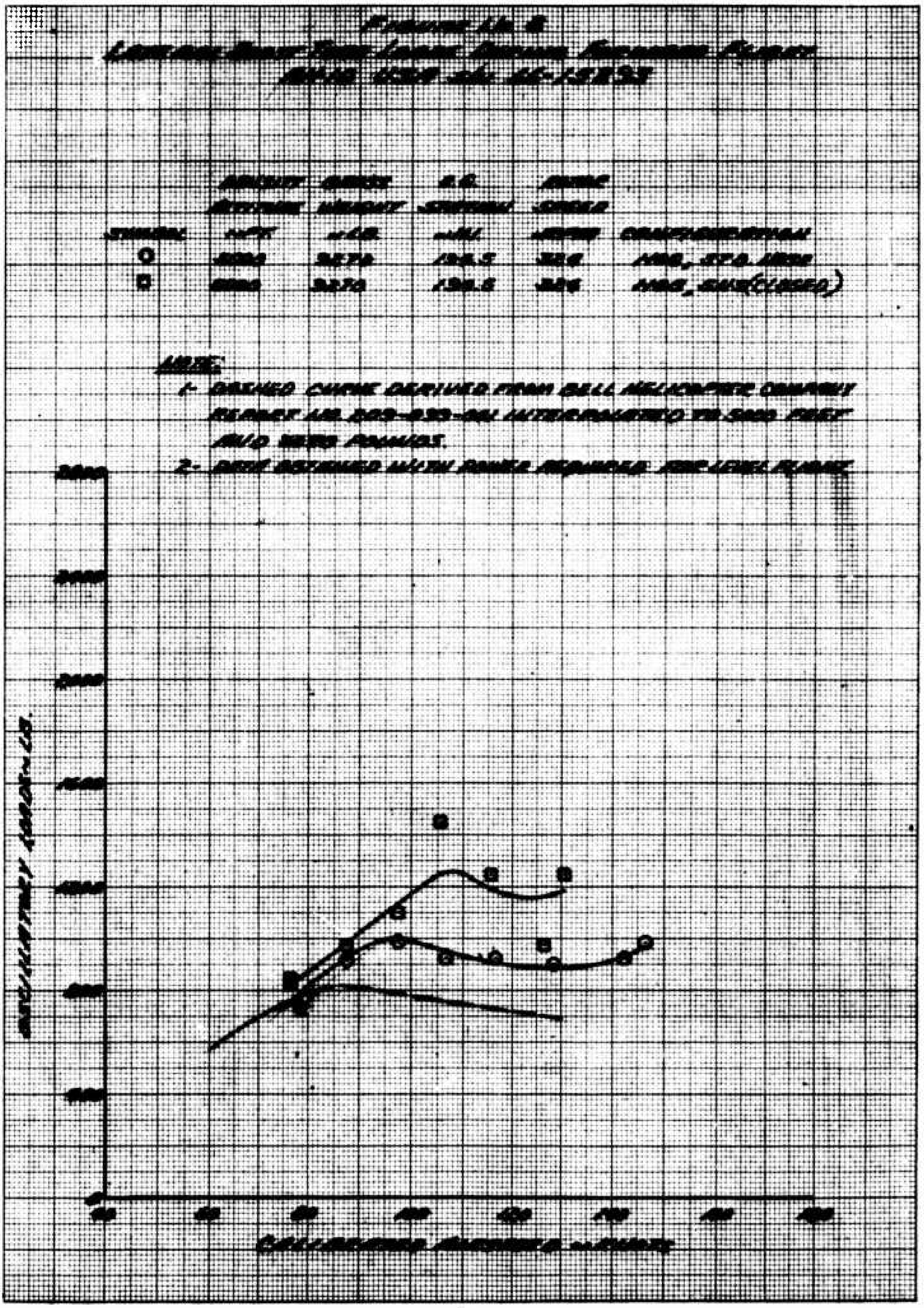

NOTE:
1- DASHED CURVE DERIVED FROM BELL HELICOPTER COMPANY

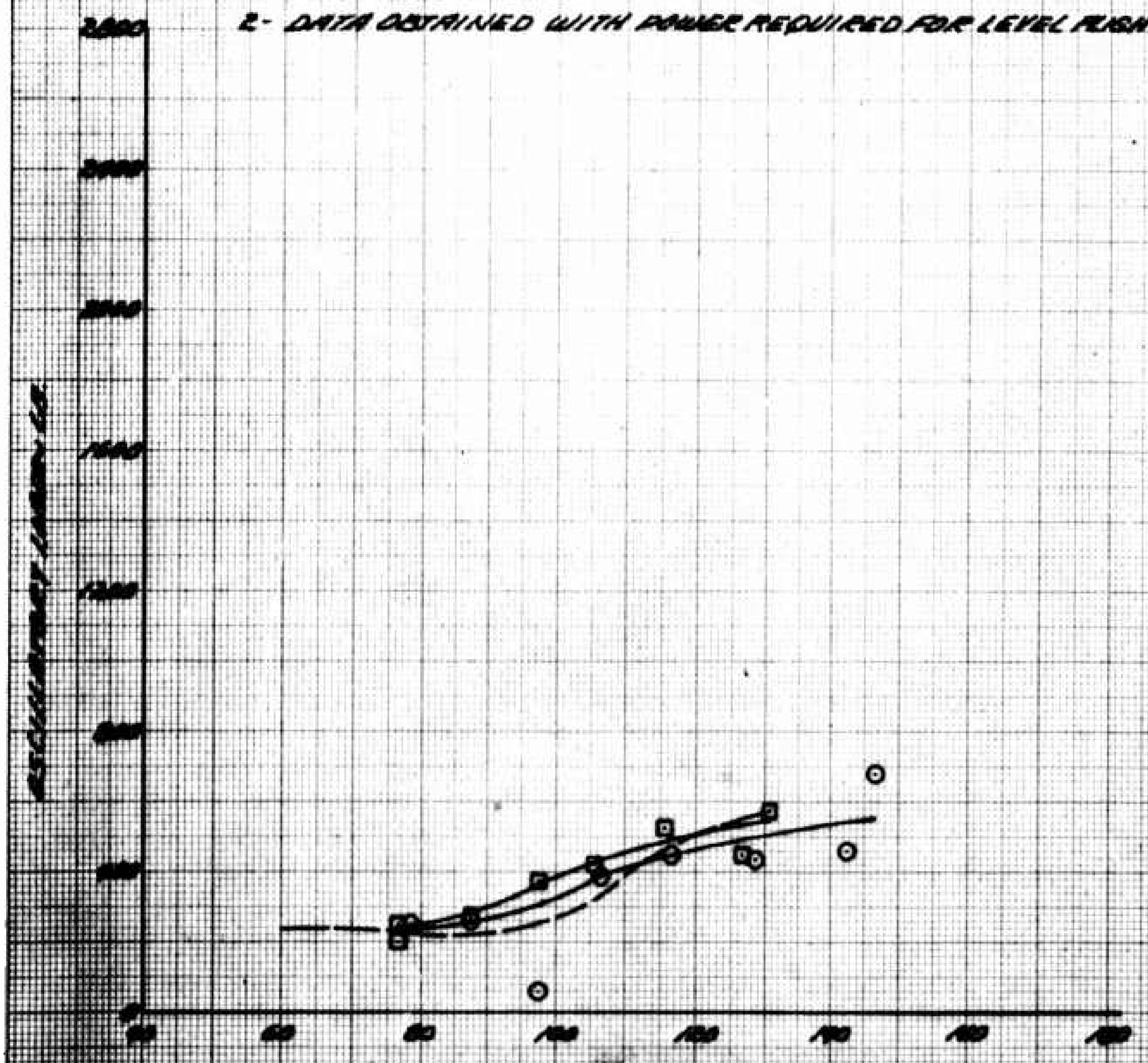
FIGURE NO. 9
COLLECTIVE BOOST TUBE LOADS DURING FORWARD FLIGHT
AH-1G USA S/N 66-15293

SYMBOL	DENSITY ALTITUDE ~FT.	GROSS WEIGHT ~LB.	C.G. STATION ~IN.	ROTOR SPEED ~RPM	CONFIGURATION
○	5000	9270	194.5	324	HOG, STD. NOSE
□	5000	9270	194.5	324	HOG, SNS (CLOSED)

NOTE:

1- DASHED CURVE DERIVED FROM BELL HELICOPTER COMPANY REPORT NO. 209-099-061 INTERPOLATED TO 5000 FEET AND 9270 POUNDS.

2- DATA OBTAINED WITH POWER REQUIRED FOR LEVEL FLIGHT.



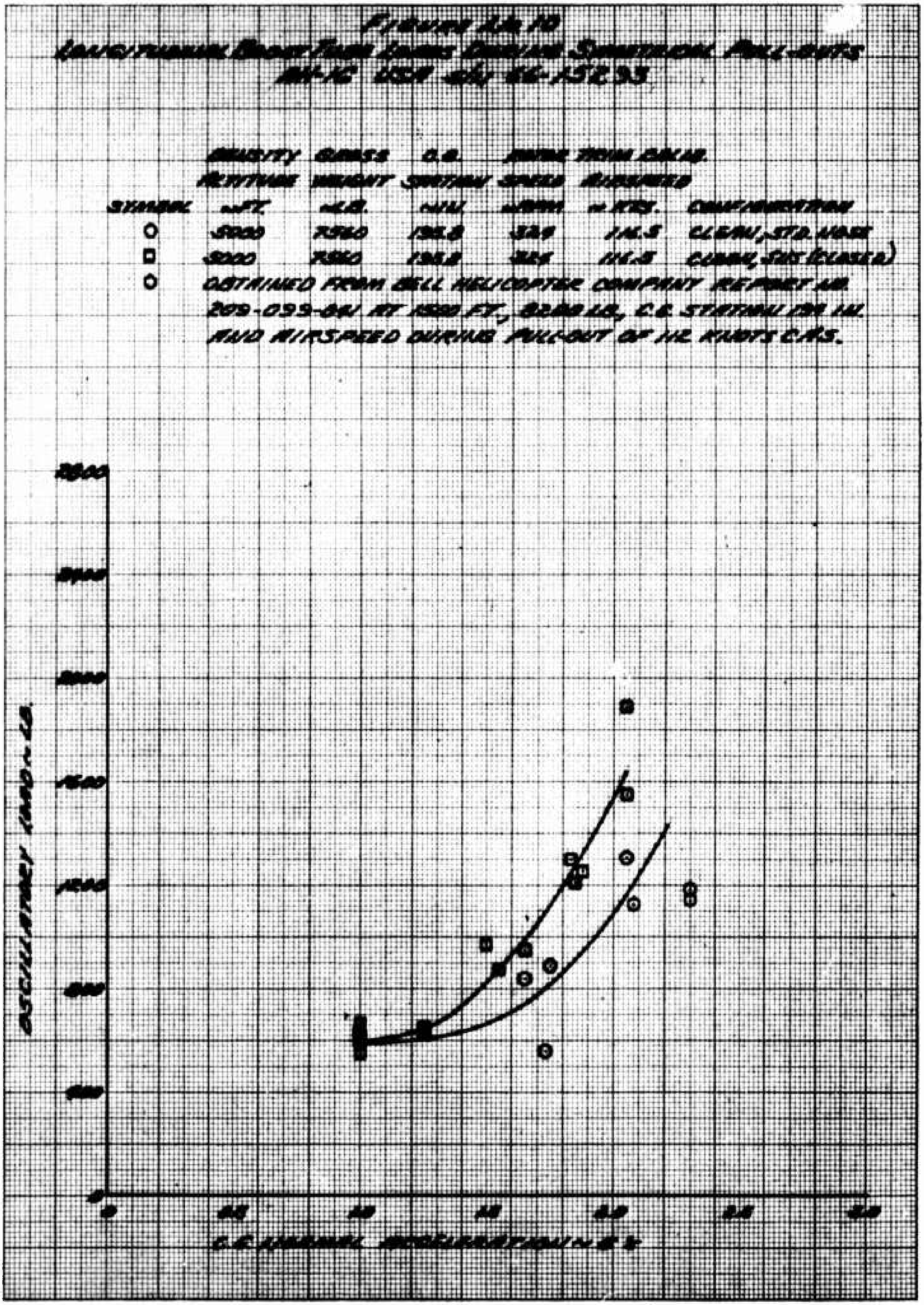

SYMBOL
CONFIGURATION
OBTAINED FROM BELL HELICOPTER COMPANY REPORT NO.
209-099-041 AT 1500 FT.,
AND AIRSPEED DURING PULL-OUT OF 112 KNOTS C.A.S.
OSCILLATORY LOAD ~ LB.
C.G. NORMAL ACCELERATION ~ G'S

FIGURE No. 11
LATERAL BOOST TUBE LOADS DURING SYMMETRICAL PULL-OUTS
AH-1G USA S/N 66-15293

SYMBOL	DENSITY ALTITUDE ~FT.	GROSS WEIGHT ~LB.	C.G. STATION ~IN.	ROTOR SPEED ~RPM	TRIM CALIB. AIRSPEED ~KTS.	CONFIGURATION
○	[illegible]	7560	195.8	324	116.5	CLEAN, STD. NOSE
□	3000	7560	195.8	324	116.5	CLEAN, [illegible])
○	OBTAINED FROM BELL HELICOPTER COMPANY REPORT NO. 209-099-041 AT 1500 FT., 8200 LB., C.G. STATION 198 IN. AND AIRSPEED DURING PULL-OUT OF 112 KNOTS CAS.					

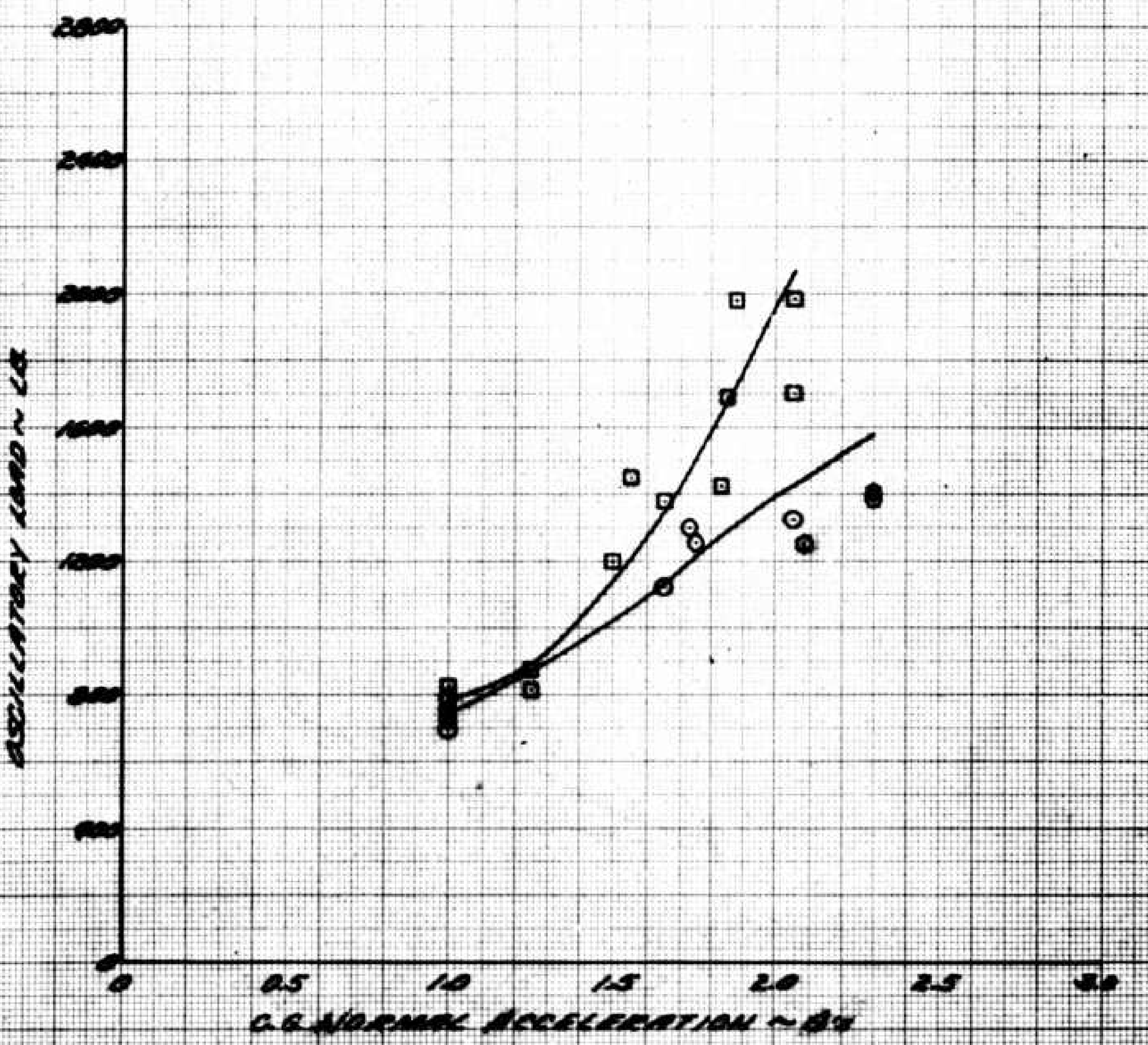


FIGURE NO. 12

COLLECTIVE BOOST TUBE LOADS DURING SYMETRICAL PULL-OUTS

AH-1G USA S/N 66-15293

SYMBOL	DENSITY ALTITUDE ~FT.	GROSS WEIGHT ~LB.	C.G. STATION ~IN.	ROTOR SPEED ~RPM	TRIM CALIB. AIRSPEED ~KTS.	CONFIGURATION
○	5000	7560	195.8	324	116.5	CLEAN, STD. NOSE
□	5000	7560	195.8	324	116.5	CLEAN, SNS (CLOSED)
⬡	OBTAINED FROM BELL HELICOPTER COMPANY REPORT NO. 209-099-041 AT 1500 FT., 8200 LB., C.G. STATION 194 IN. AND AIRSPEED DURING PULL-OUT OF 112 KNOTS CAS.					

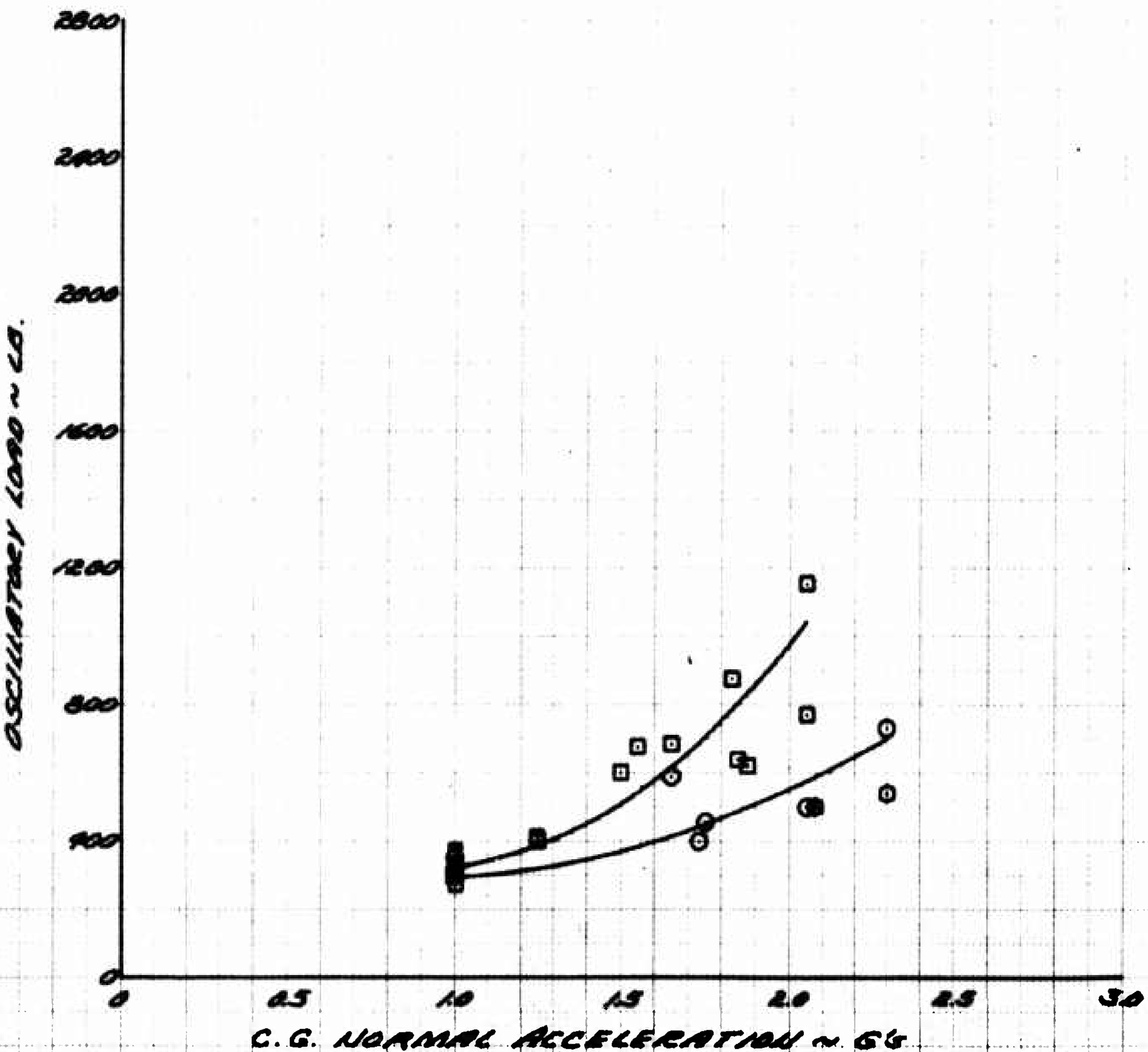


FIGURE No. 13

LONGITUDINAL BOOST TUBE LOADS DURING SYMETRICAL PULL-OUTS

AH-1G USA S/N 66-15293

SYMBOL	DENSITY ALTITUDE ~FT.	GROSS WEIGHT ~LB.	C.G. STATION ~IN.	ROTOR SPEED ~RPM	TRIM CALIB. AIRSPEED ~KTS.	CONFIGURATION
O	5000	7560	195.8	324	141.5	CLEAN, STD. NOSE
□	5000	7560	195.8	324	141.5	CLEAN, SUS (CLOSED)
O	OBTAINED FROM BELL HELICOPTER COMPANY REPORT NO. 209-099-041 AT 1500 FT., 8200 LB., C.G. STATION 194 IN. AND AIRSPEED DURING PULL-OUT OF 149.5 KNOTS CAS.					

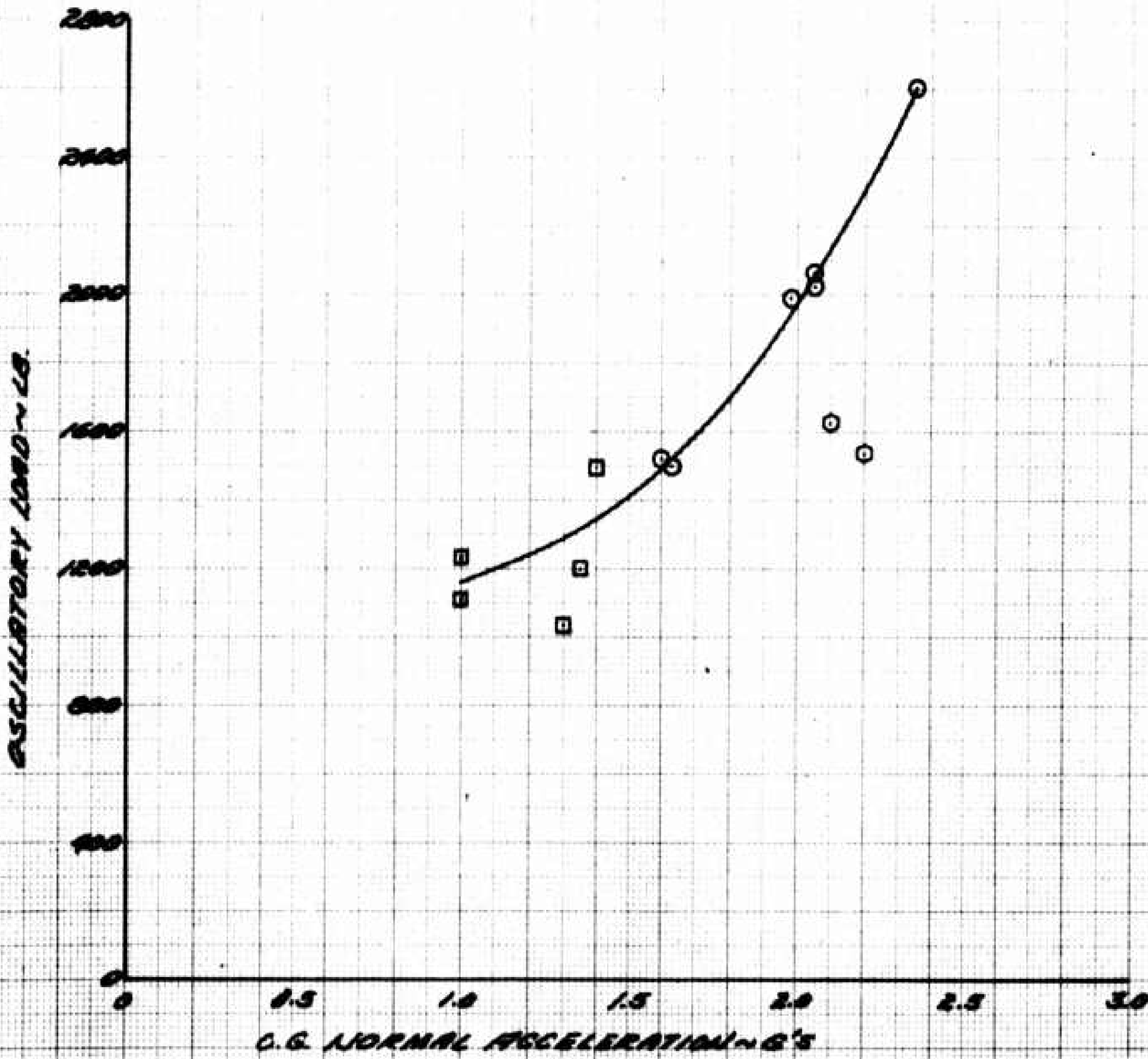
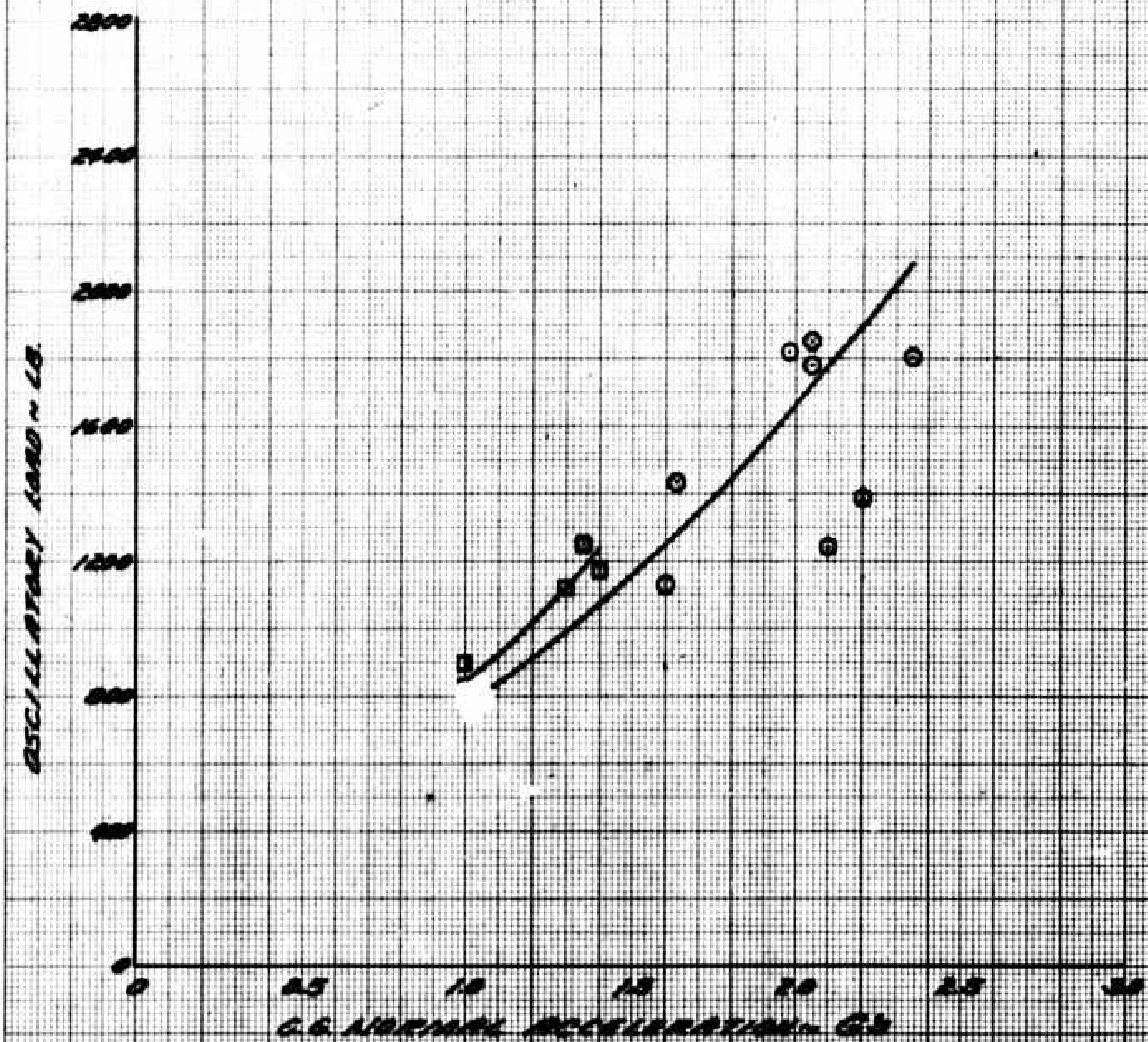


FIGURE NO. 14
LATERAL BOOST TUBE LOADS DURING SYMMETRICAL PULL-OUTS
AH-1G USA S/N 66-15235

SYMBOL	DENSITY ALTITUDE ~FT.	GROSS WEIGHT ~LB.	C.G. STATION ~IN.	ROTOR SPEED ~RPM	TRUE CALIB. AIRSPEED ~KTS.	CONFIGURATION
○	5000	7560	196.8	324	141.5	CLEAN, STD. BASE
□	5000	7560	196.4	324	141.5	CLEAN, SUS(CLOSED)

○ OBTAINED FROM BELL HELICOPTER COMPANY REPORT NO. 209-099-041 AT 1500 FT., 8200 LB., C.G. STATION 196 IN. AND AIRSPEED DURING PULL-OUT OF 149.5 KNOTS CAS.



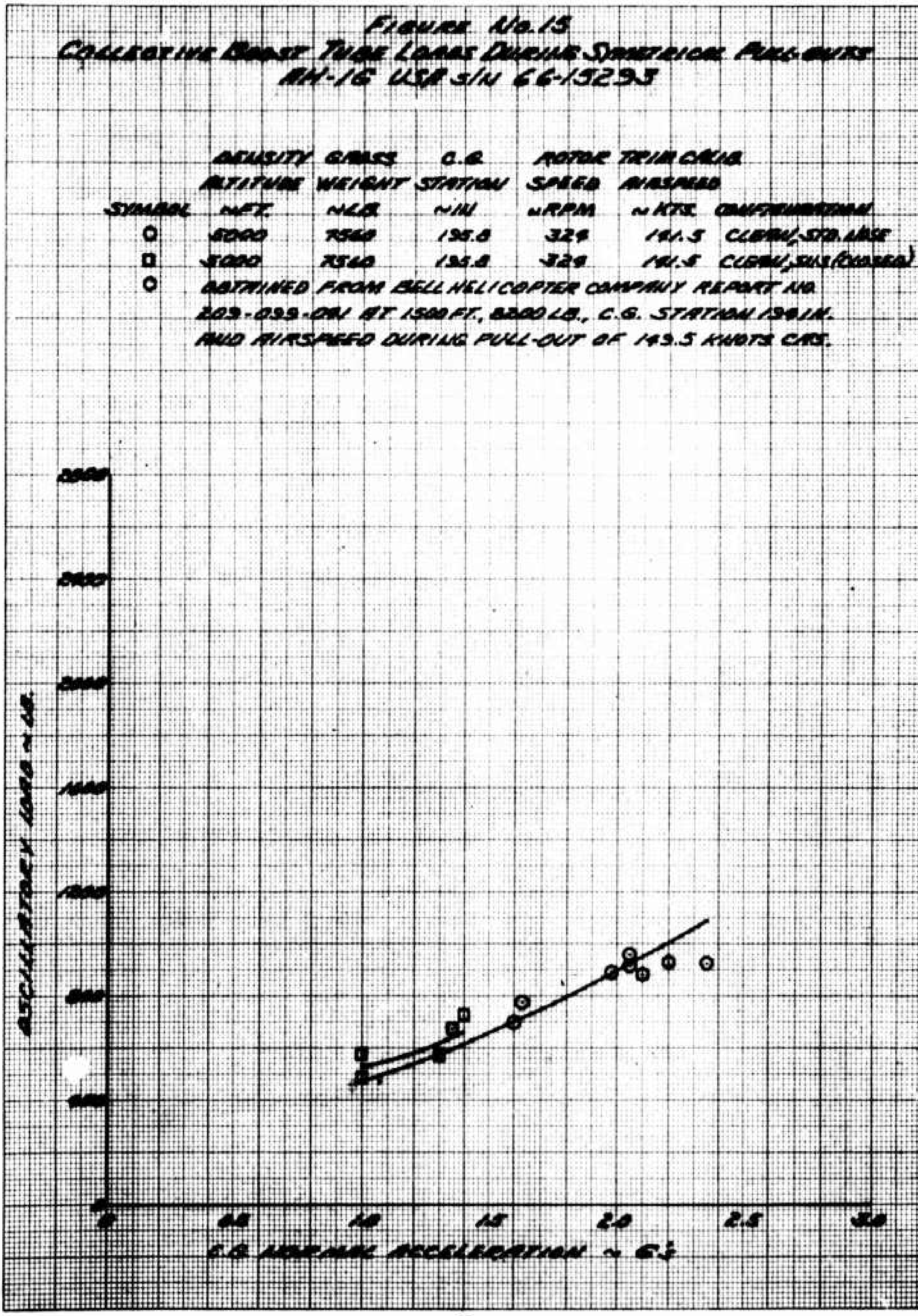


FIGURE NO. 15
COLLECTIVE BOOST TUBE LOADS DURING SYMMETRICAL PULL-OUTS
AH-1G USA S/N 66-15293
DENSITY ALTITUDE ~FT.
GROSS WEIGHT ~LB.
C.G. STATION ~IN
ROTOR SPEED ~RPM
TRIM CALIB. AIRSPEED ~KTS.
CONFIGURATION
SYMBOL
7560
329
141.5
OBTAINED FROM BELL HELICOPTER COMPANY REPORT NO.
203-099-
AND AIRSPEED DURING PULL-OUT OF 143.5 KNOTS CAS.
OSCILLATORY LOAD ~ LB.
0
0.5
1.0
1.5
2.0
2.5
3.0
C.G. NORMAL ACCELERATION ~ G's

FIGURE NO. 16
STATIC LONGITUDINAL STABILITY
LEVEL FLIGHT
AH-1G USA S/N 66-15293

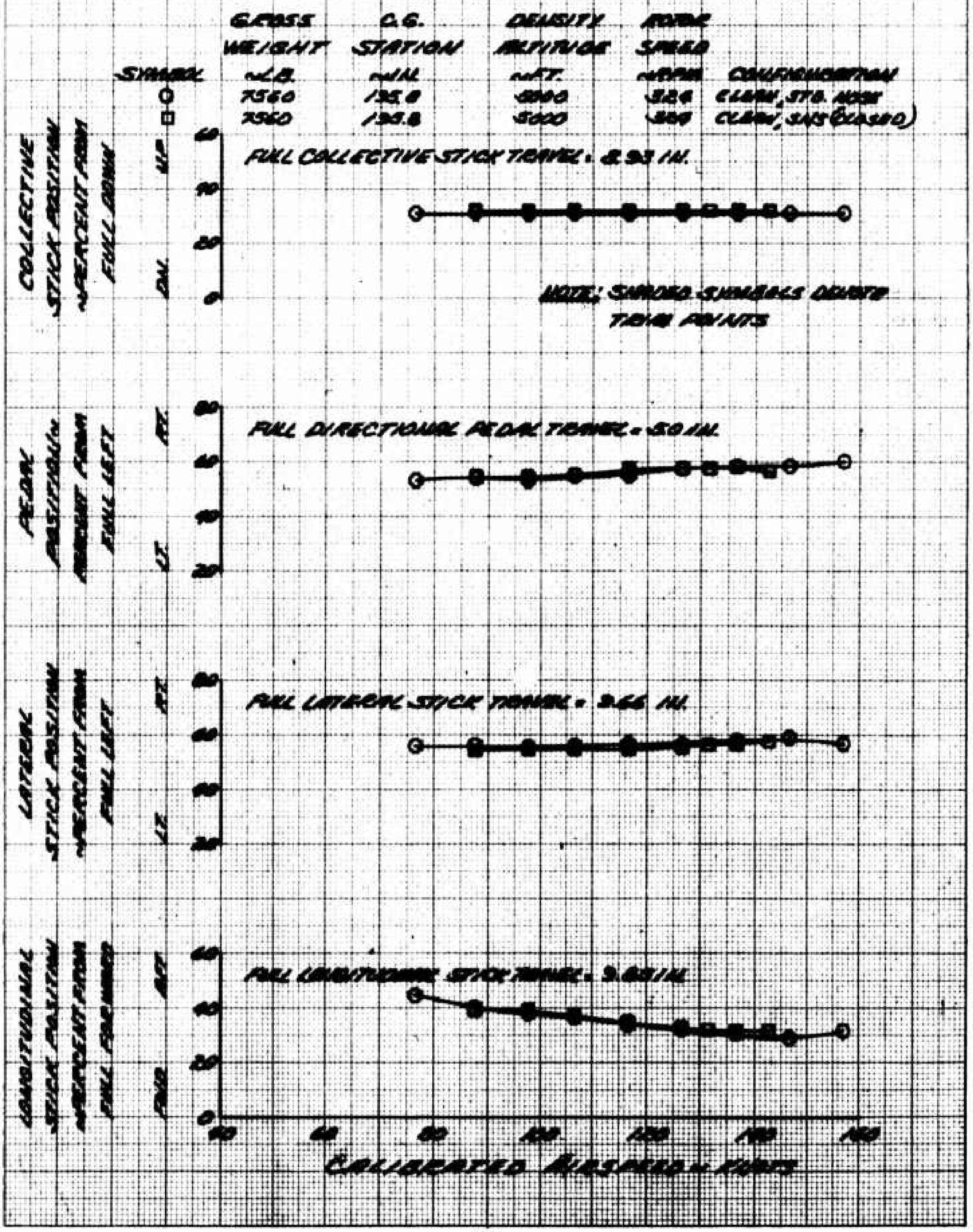


FIGURE NO. 17
STATIC LONGITUDINAL STABILITY
LEVEL FLIGHT
AH-1G USA S/N 66-15293

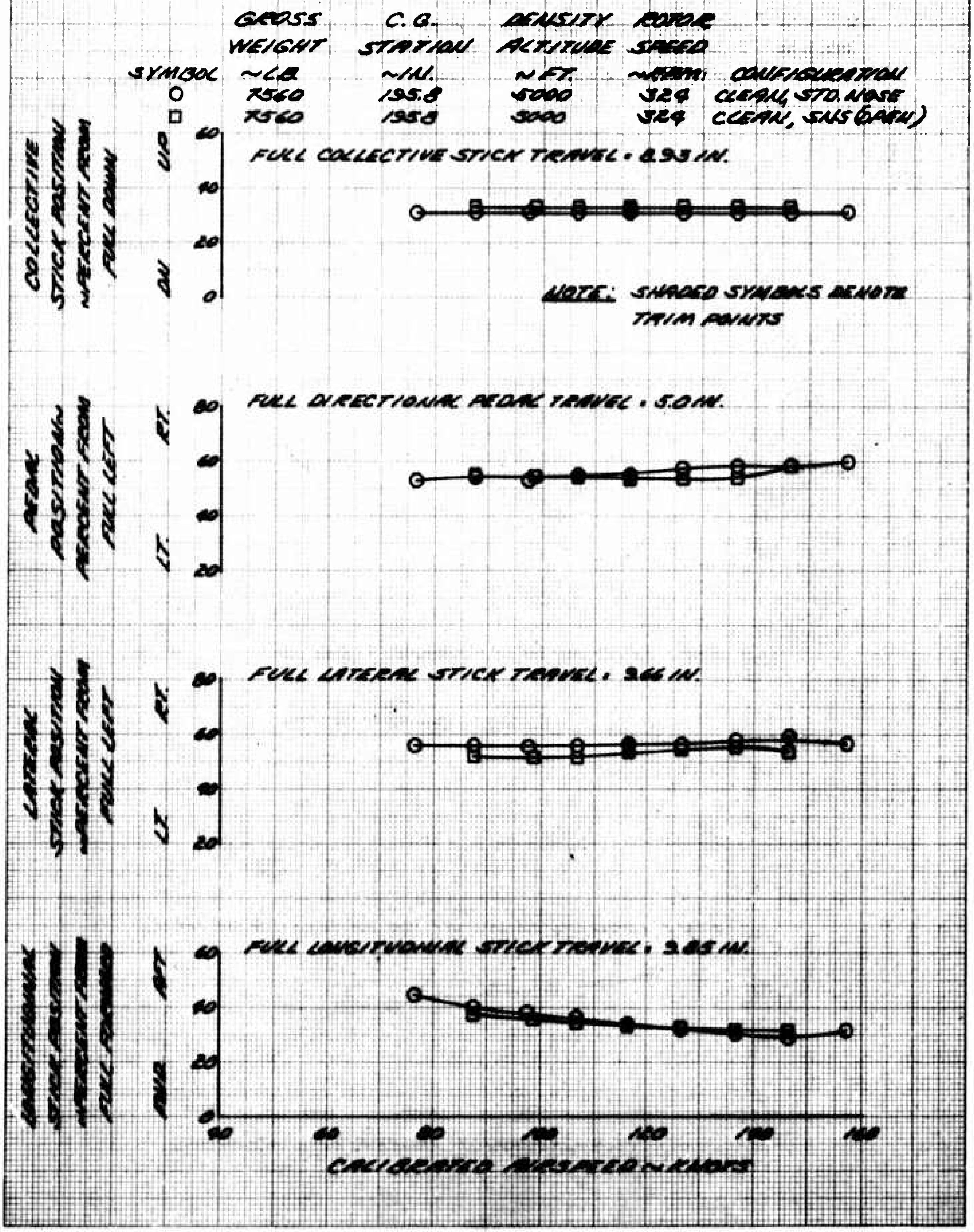


FIGURE No. 18
STATIC LONGITUDINAL STABILITY
LEVEL FLIGHT
AH-1G USA S/N 66-15293

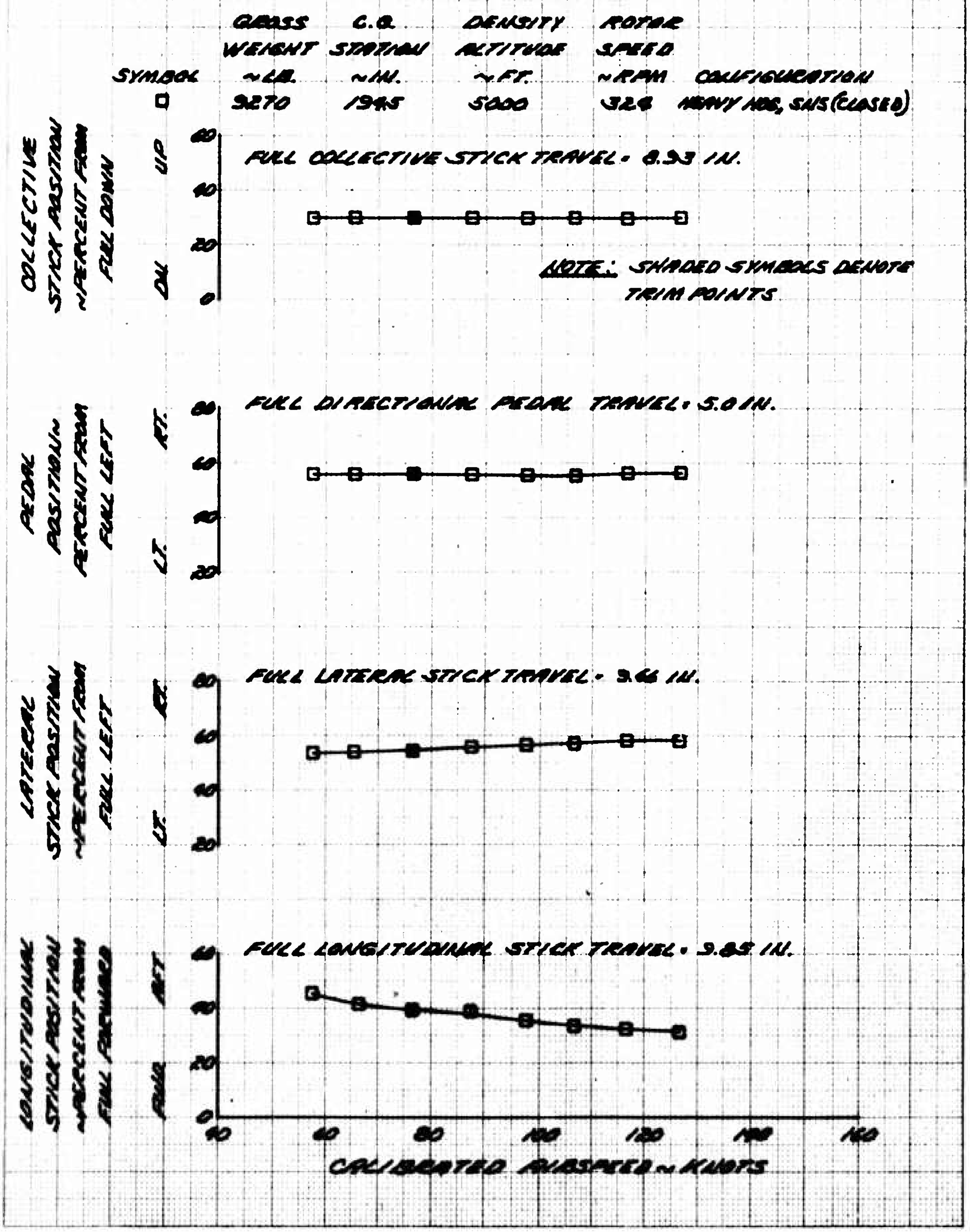
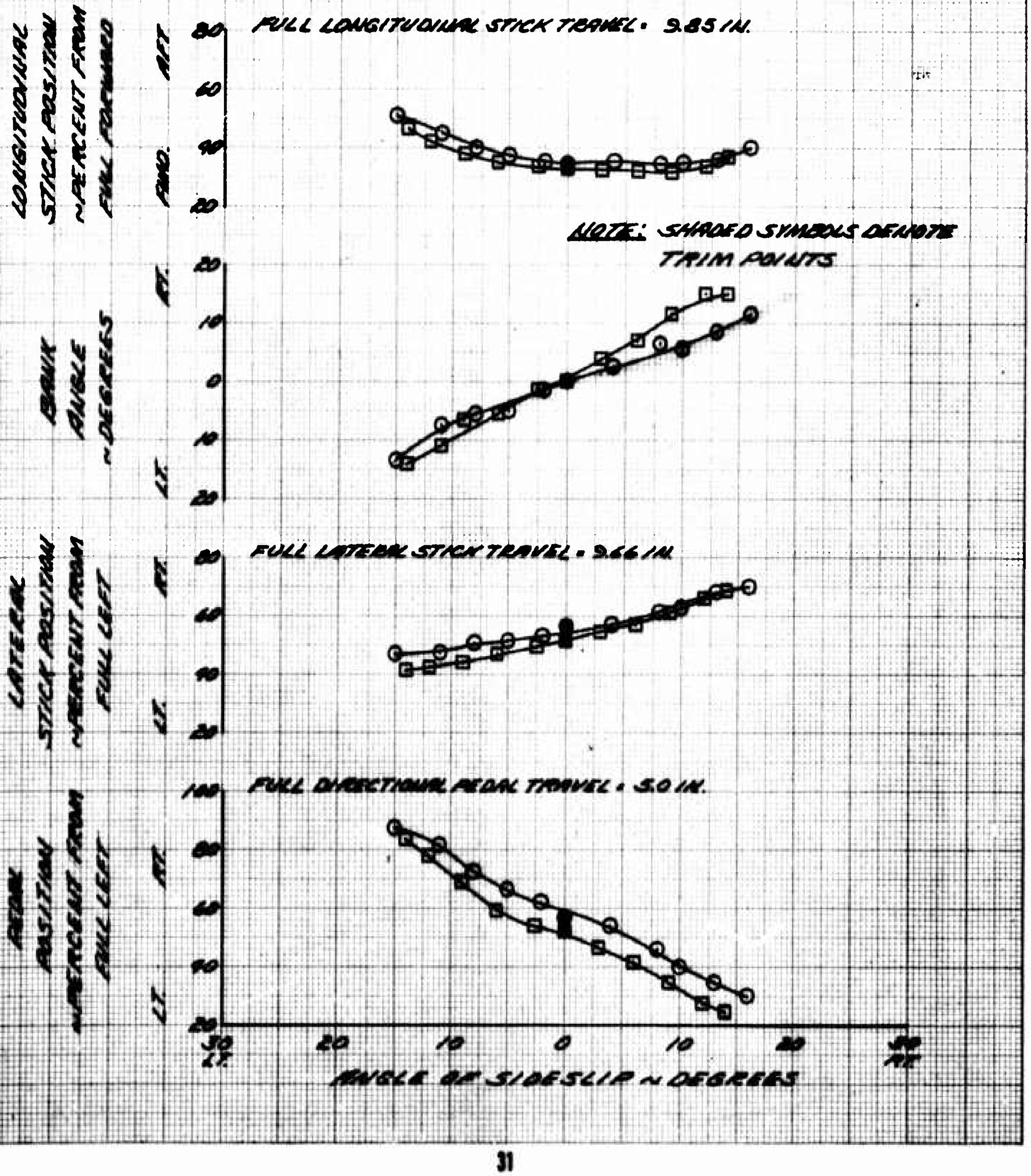


FIGURE NO. 19
STATIC LATERAL - DIRECTIONAL STABILITY
LEVEL FLIGHT
AH-1G USA S/N 66-15293

SYMBOL	GROSS WEIGHT ~LB.	C.G. STATION ~IN.	DENSITY ALTITUDE ~FT.	ROTOR SPEED ~RPM	CALIBRATED AIRSPEED ~KTS.	CONFIGURATION
○	7560	195.8	5000	324	116.5	CLEAN, STD. NOSE
□	7560	195.8	5000	324	116.5	CLEAN, SMS (CLOSED)



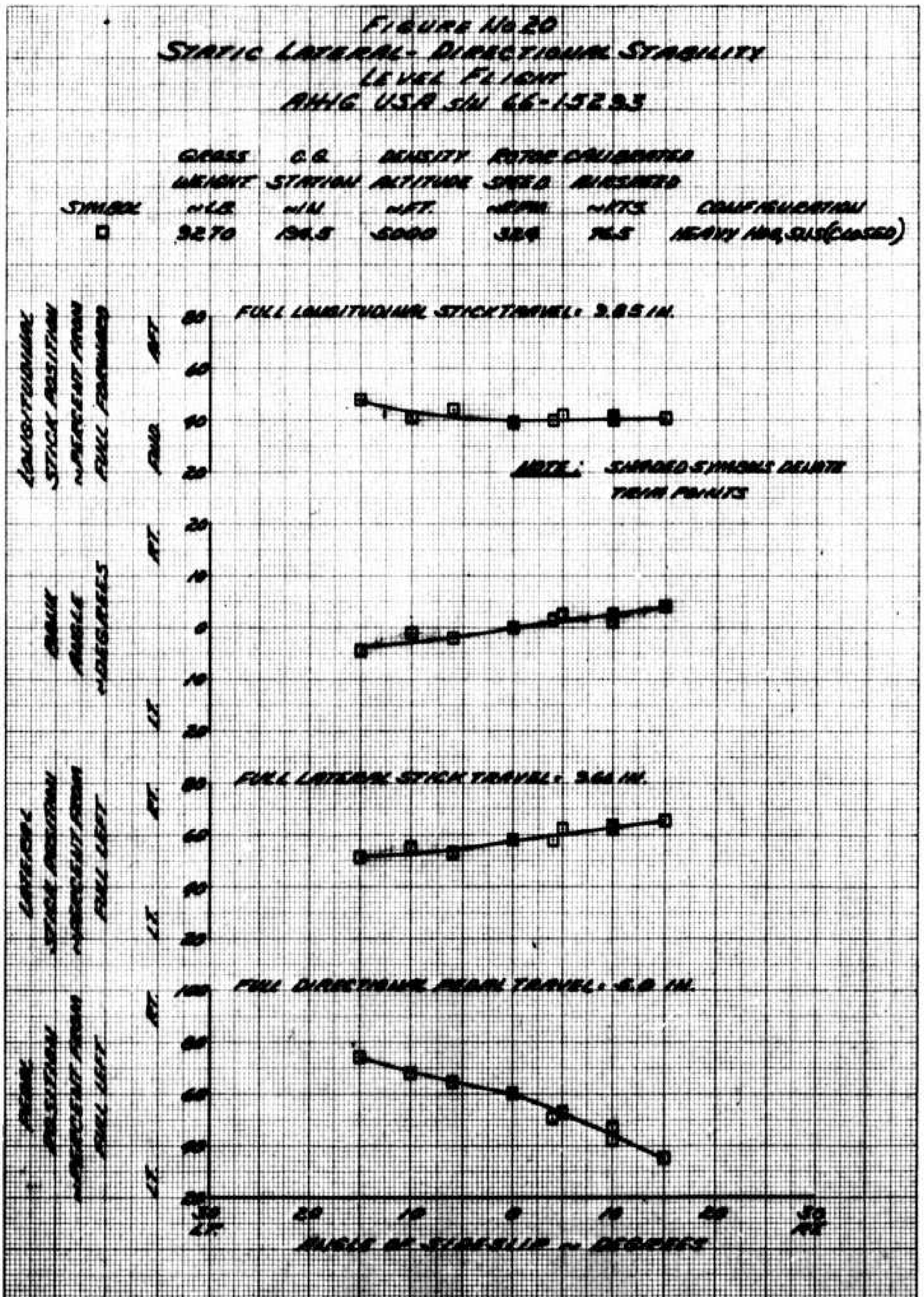


FIGURE NO. 20
STATIC LATERAL-DIRECTIONAL STABILITY
LEVEL FLIGHT
AH-1G USA S/N 66-15293
SYMBOL
GROSS WEIGHT ~LB.
C.G. STATION ~IN.
DENSITY ALTITUDE ~FT.
ROTOR SPEED ~RPM.
CALIBRATED AIRSPEED ~KTS.
CONFIGURATION
3270
194.5
5000
324
76.5
HEAVY HOG, SUS (CLOSED)
FULL LONGITUDINAL STICK TRAVEL: 3.85 IN.
LONGITUDINAL STICK POSITION ~PERCENT FROM FULL FORWARD
AFT
FWD
NOTE: SHADED SYMBOLS DENOTE TRIM POINTS
BANK ANGLE ~DEGREES
RT.
LT.
FULL LATERAL STICK TRAVEL: 3.64 IN.
LATERAL STICK POSITION ~PERCENT FROM FULL LEFT
FULL DIRECTIONAL PEDAL TRAVEL: 6.8 IN.
PEDAL POSITION ~PERCENT FROM FULL LEFT
ANGLE OF SIDESLIP ~ DEGREES
LT.
RT.

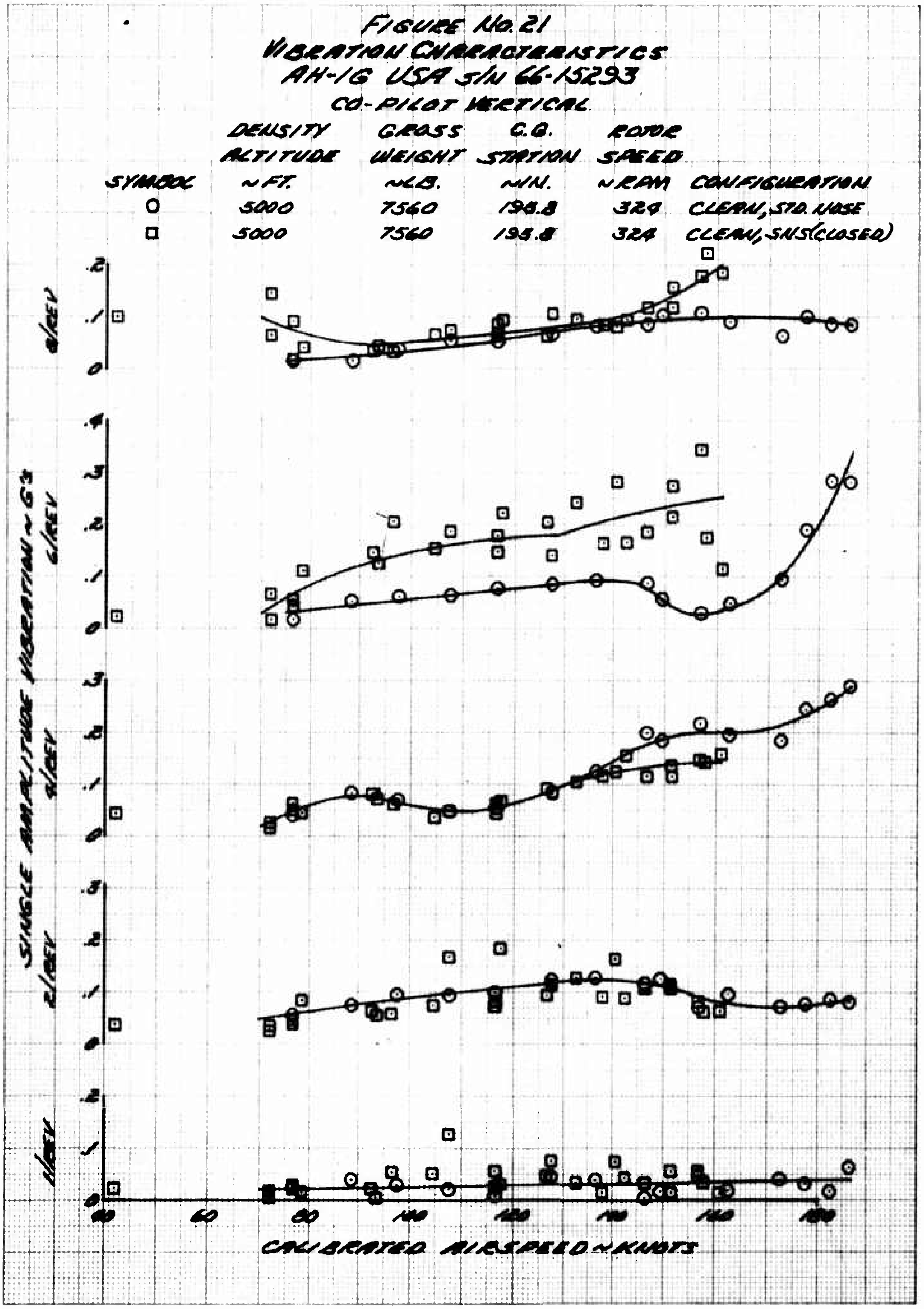
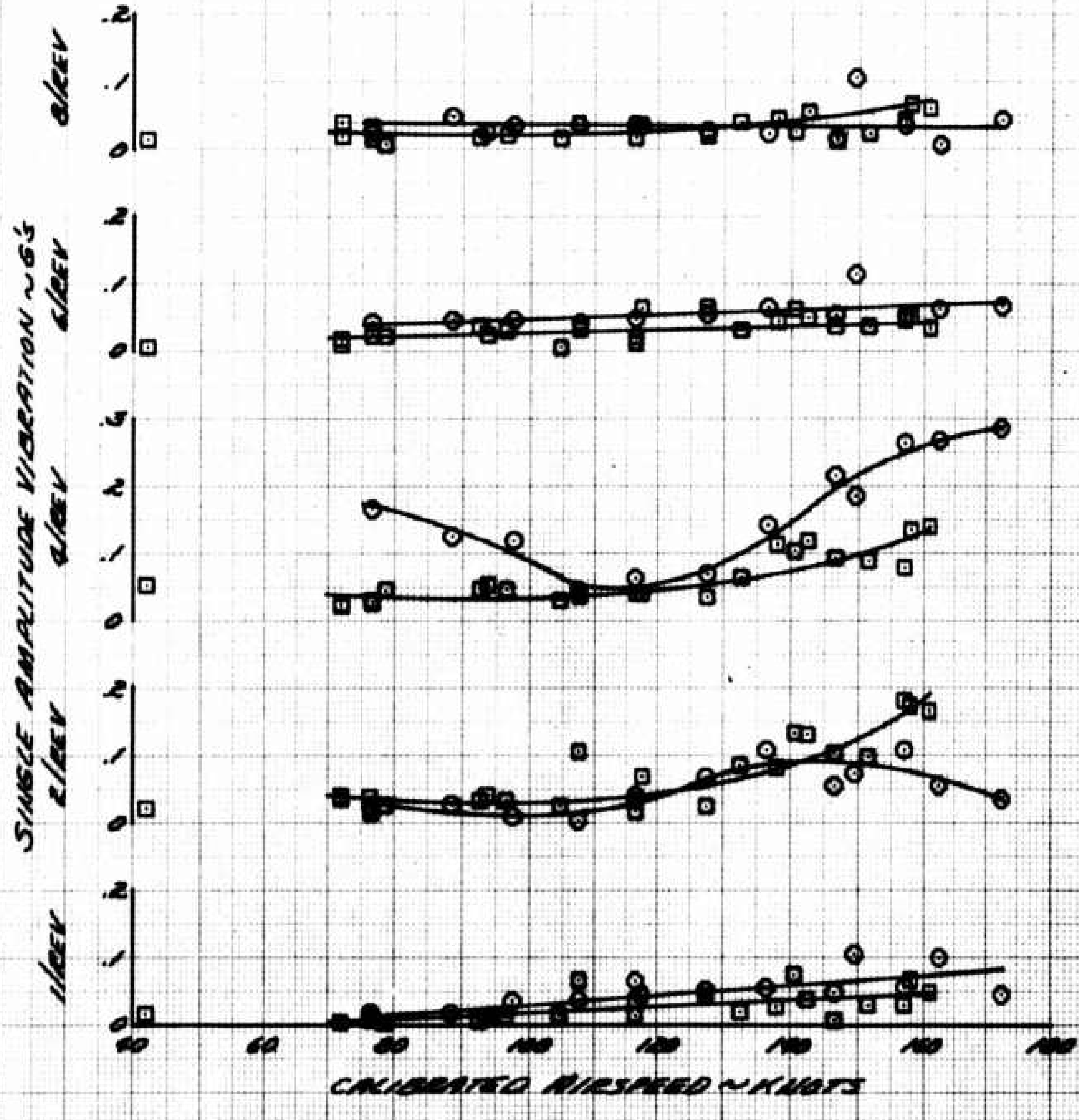


FIGURE NO. 21
VIBRATION CHARACTERISTICS
AH-1G USA S/N 66-15293
CO-PILOT VERTICAL
DENSITY ALTITUDE ~FT.
GROSS WEIGHT ~LB.
C.G. STATION ~IN.
ROTOR SPEED ~RPM
SYMBOL
CONFIGURATION
5000 7560 193.8 324 CLEAN, STD. NOSE
5000 7560 193.8 324 CLEAN, SNS (CLOSED)
SINGLE AMPLITUDE VIBRATION ~ G's
8/REV
6/REV
4/REV
2/REV
1/REV
0
.1
.2
.3
.4
40
60
80
100
120
140
160
180
CALIBRATED AIRSPEED ~ KNOTS

FIGURE NO. 22
VIBRATION CHARACTERISTICS
AH-1G USA S/N 66-15293
CO-PILOT LATERAL

SYMBOL	DENSITY ALTITUDE ~FT.	GROSS WEIGHT ~LB.	C.G. STATION ~IN.	ROTOR SPEED ~RPM	CONFIGURATION
O	5000	7560	196.8	324	CLEAN, STD. NOSE
□	5000	7560	196.8	324	CLEAN, SUS (CLOSED)



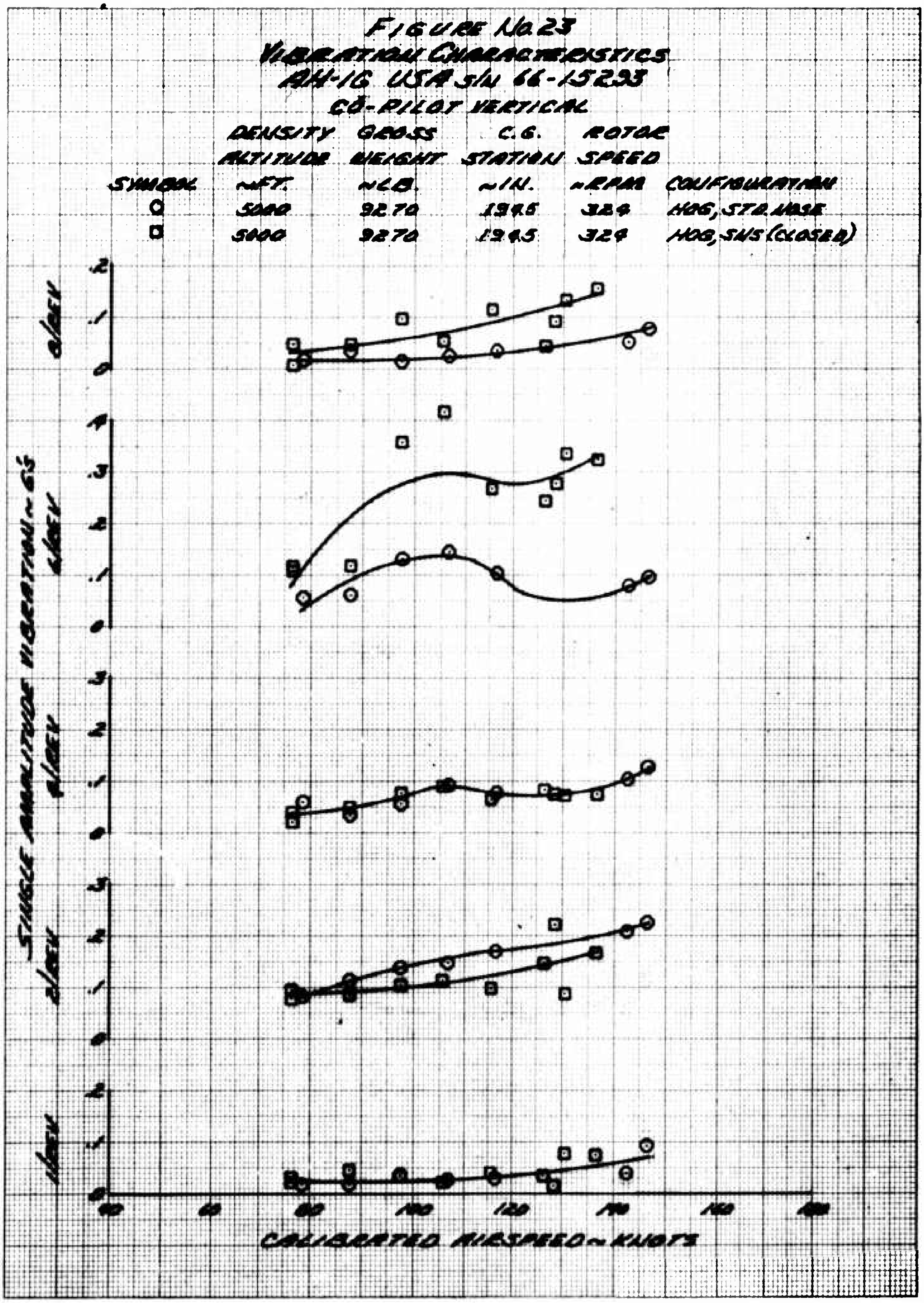
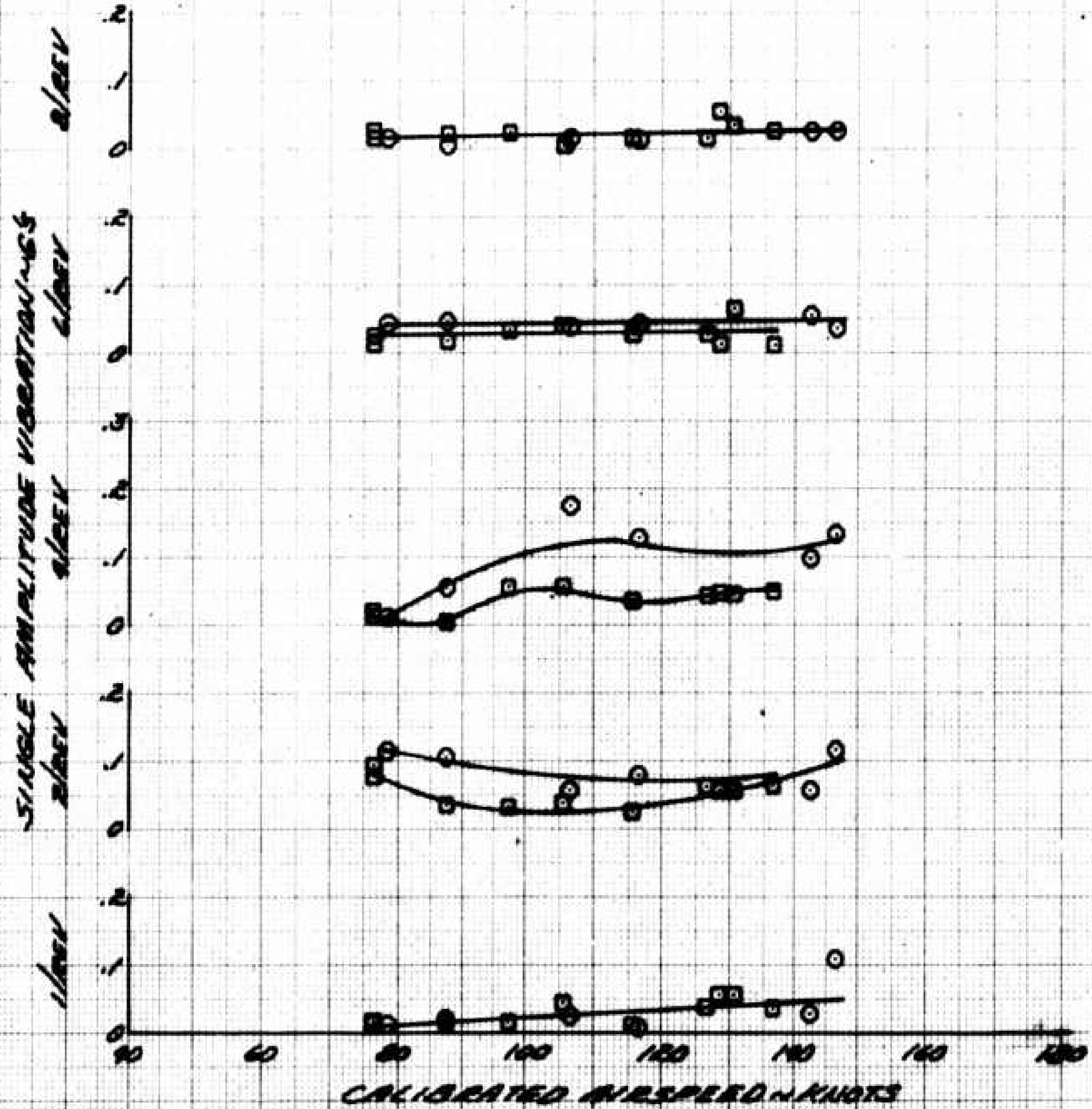


FIGURE NO. 23
VIBRATION CHARACTERISTICS
AH-1G USA S/N 66-15293
CO-PILOT VERTICAL
SYMBOL | DENSITY ALTITUDE ~FT. | GROSS WEIGHT ~LB. | C.G. STATION ~IN. | ROTOR SPEED ~RPM | CONFIGURATION
○ | 5000 | 9270 | 194.5 | 324 | HOG, STD. NOSE
□ | 5000 | 9270 | 194.5 | 324 | HOG, SNS (CLOSED)
SINGLE AMPLITUDE VIBRATION ~ G'S
1/REV
40
60
80
100
120
140
160
180
CALIBRATED AIRSPEED ~ KNOTS

FIGURE NO. 29
VIBRATION CHARACTERISTICS
AH-1G USA S/N 66-15293
CO-PILOT LATERAL

SYMBOL	DENSITY ALTITUDE ~FT.	GROSS WEIGHT ~LB.	C.G. STATION ~IN.	ROTOR SPEED ~RPM	CONFIGURATION
○	5000	8870	194.5	324	HOG, STD. NOSE
□	5000	8870	194.5	324	HOG, SNS (CLOSED)



APPENDIX III. TEST INSTRUMENTATION

1. A swivel-mounted pitot-static airspeed head was installed on a boom which extended approximately 5 feet in front of the nose of the helicopter. This airspeed head was used as a source for the sensitive altitude and airspeed systems. Vanes attached to the boom were used to measure angles of attack and sideslip. Sensitive instrumentation was installed to measure the following parameters:

a. Pilot's Panel

Longitudinal cyclic stick position
Lateral cyclic stick position
Collective stick position
Pedal position
Boom airspeed
Boom altitude
Rotor rpm
Angle of attack
Angle of sideslip
Gas producer speed (N_1)
Engine rpm (N_2)
Exhaust gas temperature
Normal acceleration (G)
Rate of climb

b. Engineer's Panel

Hi-torque pressure
Lo-torque pressure
Rotor rpm
Standard airspeed
Standard altitude
Gas producer speed (N_1)
Outside air temperature
Exhaust gas temperature
Fuel used
Oscillograph record number

c. Oscillograph

Longitudinal stick position
SCAS longitudinal position
Pitch angle
Pitch rate
Lateral stick position
SCAS lateral position

Roll angle
Roll rate
Pedal position
SCAS pedal position
Yaw angle
Yaw rate
Angle of sideslip
Angle of attack
Collective position
Throttle position
Normal acceleration (G)
Linear rotor rpm
Rotor blip
Voltage monitor
Pilot's event
Engineer's event
Tail rotor torque
Tail rotor blade angle
Horizontal stabilizer position
Lateral and vertical vibration at copilot's station
FS 79, water line (WL) 52, butt line (BL) 10 right

d. Oscillograph Strain Gage

Control link/tube, BHC P/N 209-030-124-1
Control link/tube, BHC P/N 209-030-124-3
Control link/tube, BHC P/N 209-030-124-5
Tail boom longeron, BHC P/N 209-030-806-15
SNS structure (gage D8, Itek package)
SNS structure (gage B5, Itek package)
SNS structure (gage E8, Itek package)
SNS structure (gage B4, Itek package)
Horizontal stabilizer chordwise bending
Horizontal stabilizer beamwise bending
Horizontal stabilizer torsional bending

APPENDIX IV. STANDARD AH-IG OPERATING LIMITATIONS AND DIMENSIONS

LIMIT AIRSPEED (V_L)

Hog or alternate configuration: 180 KIAS below a 3000-foot H_D; decrease 8 KIAS per 1000 feet above 3000 feet

All other configurations: 190 KIAS below a 4000-foot H_D; decrease 8 KIAS per 1000 feet above 4000 feet

GROSS WEIGHT - CENTER OF GRAVITY ENVELOPE

Forward limit: Below 7000 pounds, FS 190; linear decrease from FS 190 at 7000 pounds to FS 192.1 at 9500 pounds

Aft limit: Below 8270 pounds, FS 201; linear decrease from FS 201 at 8270 pounds to FS 200 at 9500 pounds

SIDESLIP LIMITS

Five degrees at 190 KIAS; linear increase to 20 degrees at 60 KIAS

RPM LIMITS

Rotor:
- 294 to 324 rpm, continuous operation
- 339 rpm, maximum for autorotation

Engine:
- 6000 to 6400 rpm, 0 to 70 knots
- 6400 to 6600 rpm, continuous operation
- 6600 rpm, maximum
- 6750 rpm, maximum at or below 91-percent gas producer speed (N_1)

TEMPERATURE AND PRESSURE LIMITS

Engine oil temperature	93°C
Transmission oil temperature	110°C
Engine oil pressure	25 to 100 psi
Transmission oil pressure	30 to 70 psi
Fuel pressure	5 to 20 psi

T53-L-13 ENGINE LIMITS (Installed)

Normal rated (maximum continuous)	625°C
Military rated (30-minute limit)	645°C
Starting and acceleration (5-second limit)	675°C
Maximum for starting and acceleration	760°C
Torque pressure	50 psi

PHYSICAL CHARACTERISTICS

Aircraft length (rotors turning)	635.7 inches
Fuselage length	535.1 inches
Maximum fuselage width (including stub wings)	124.0 inches
Maximum fuselage width (without stub wings)	36.0 inches

MAIN ROTOR

Rotor diameter	528 inches
Chord	27 inches
Disc area	1520.4 ft^2
Blade area (each)	49.5 ft^2
Solidity ratio	0.0651

AIRCRAFT WEIGHTS

Empty weight (S/N 66-15355)	5789 pounds
Design gross weight	6600 pounds
Maximum gross weight	9500 pounds

UNCLASSIFIED

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13. ABSTRACT

The Phase I airworthiness and flight characteristics tests of the AH-1G helicopter with the mock-up stabilized night sight (SNS) installed indicated a feasibility for further development utilizing the actual SNS equipment. No significant changes in the handling qualities due to the SNS modification were noted during the tests. The static, proof load test results indicate that the structure is adequate to withstand the required loads. The flight test data from the three nonrotating control boost tubes show higher loads for the AH-1G in both the SNS and standard nose configurations than the Bell Helicopter Company test data. The control boost tube loads reached the maximum permitted at conditions short of the published envelope. Testing was terminated early to obtain instrumented components (rotor blade, drag brace and pitch link) so the flight envelope and/or fatigue life of these components could be more accurately determined. These tests are scheduled to be completed during Phase II with the actual SNS installed. The vertical six-per-revolution vibrations at the copilot's seat exceed military specification requirements in the SNS configuration.

DD FORM 1 NOV 65 1473 REPLACES DD FORM 1473, 1 JAN 64, WHICH IS OBSOLETE FOR ARMY USE.

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14. KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
Phase I						
Airworthiness and flight characteristics						
AH-1G helicopter						
Mock-up SNS						
Feasibility						
Handling characteristics						
Static, proof load test results						
Structure is adequate						
Boost tube loads						
Instrumented components						
Phase II						
Vibrations						